AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 17, NO. 43. WEEKLY. | NEW YORK, THURSDAY, OCTOBER 25, 1894. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

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Improved 36-inch and 42-inch Circular Re-sawing Machine.

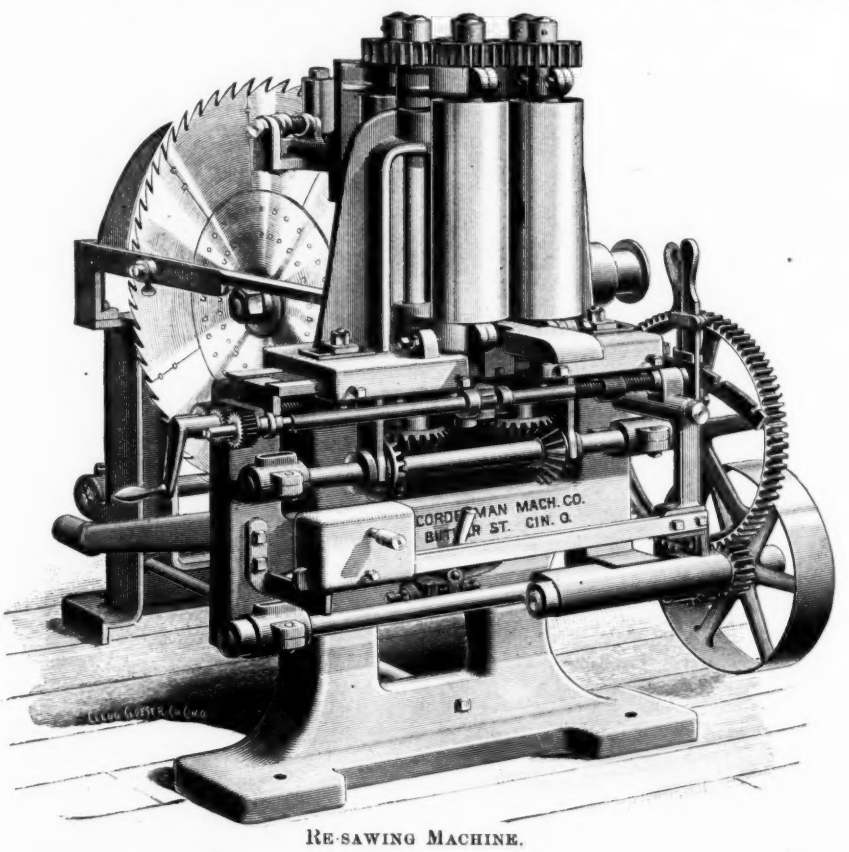
We present herewith an illustration of a re sawing machine adapted to use circular saws of 36 inches to 42 inches diameter, and these may be either solid or sectional; the makers of the machine recommending that the latter be used as they have the advantage of being thinner, and are not so liable to buckle. With such a saw the kerf need not be more than slightly over $\frac{1}{16}$ inch.

As will be seen, the machine is symmetrically and substantially designed, its weight being about 18,000 pounds.

There are four large feed rolls the full length of the working part of the saw. They are all driven by powerful and heavy gearing, and are held to their work by a heavy weight, which exerts equal pressure on each set of rolls. The feed receives its power from the saw mandrel by means of an intermediate countershaft, an arrangement which permits the tilting of the swinging feed roll frame, without altering the tension of the driving belts. The rolls are also made self-centering, which, for instance, would permit an inch board to be followed by another 1¼ inches thick, without making a separate adjustment of the rolls, and sawing both boards exactly in the center. Or, if desired, either set of rolls can be made stationary, while the other yields, by simply loosening a nut; which enables the operator to cut a quarter-inch or half-inch slab off a board of any thickness up to 4 inches. Another feature is, that the feed rolls are made to work close up to the board rest, so that half-inch strips can be cut if necessary. The housings supporting the rolls are gibbed to a heavy swinging frame, pivoted in a semi-circular bearing, and can be tilted by simply loosening a hand nut, and by this means the machine is very readily adjusted for bevel sawing—such as clapboards, siding, etc. An adjustable stop is provided for regulating the amount of bevel desired. Both sets of rolls can be adjusted at the same time, or one independently of the other, by the crank handle, shown on the end. The rolls are also adjustable in case of wear on their journals.

Idler rolls are provided outside the feed rolls, near the top of the saw for the purpose of holding the lumber as rigid on the top as on the bottom. These rolls are fitted with pressure springs and consequently act independently of the driven rolls. These will hold a thin board, while the feed rolls are opened for a thicker one following. On machines where rigid guides are used, this cannot, of course, be done. These idler rolls are fitted to the feed roll housings and move with them. They can also be adjusted vertically as the different diameters of saws require.

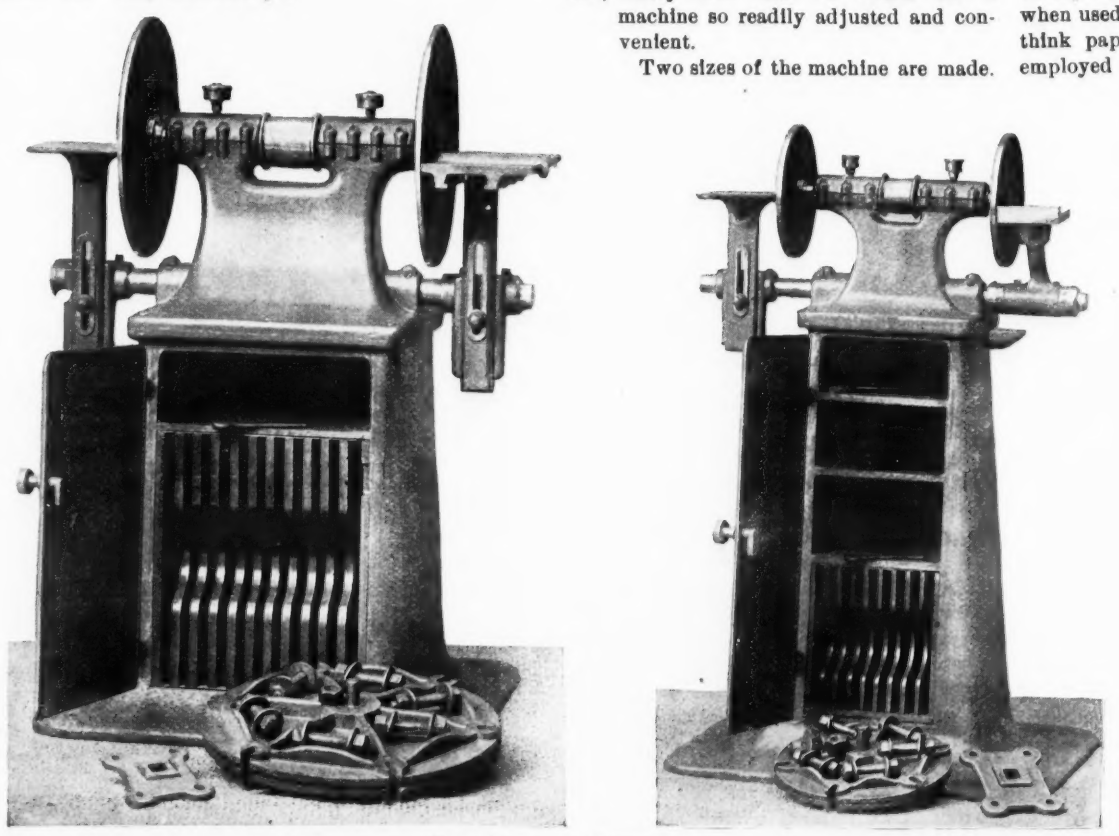
There are two rates of feed. One lever stops, starts and reverses the feed; the latter being particularly advantageous where it is necessary to draw the board from the saw without stopping or opening the feed rolls and pulling it from the saw, which is a very awkward job.



RE-SAWING MACHINE.

The mandrel is heavy, made of the best quality of steel, and driven by a pulley of unusually large diameter and face. The self oiling bearings in which it revolves, are fitted in planed grooved ways on the frame to adjust forward as required, allowing for all wear on the saw, and keeping the saw close to the rolls. In furniture, box and piano factories, planing mills, etc., many uses will be found for a machine so readily adjusted and convenient.

Two sizes of the machine are made. The 36-inch saw will split 16 inches wide; the 42-inch saw will split 19 inches wide. It is built by the Cordesman Machine Co., Cincinnati, Ohio.



THE GARDNER GRINDER.

The Gardner Grinder.

We give on this page engravings of two sizes of a grinding machine which employs a new principle in grinding, or rather perhaps applies an old principle in a new way.

Instead of using solid emery wheels these machines use disks of steel which are turned and faced true on both sides, and have upon each face a spiral groove which starts at the center and runs out to the circumference. This groove is shallow and of rectangular section, and serves to hold glue used in securing to the faces of the disk emery cloth or paper. What seems to be the most important feature of this groove, however, is that when the emery cloth is pressed strongly to the disk, and held there until the glue hardens, it is depressed slightly over the groove, and thus there is a corresponding spiral groove or depression in the abrading surface, which seems to increase its efficiency to a degree that is remarkable, the grinding being done with comparatively little heating or glazing, and very rapidly. At the same time the steel disk being always true and in perfect balance, enables true and flat surfaces to be readily ground; the fixtures furnished with the machine enabling them to be readily produced at right angles to each other when required.

At the base of the machines is shown the device by which the emery cloth or paper is pressed onto the disk and held until cold, and as both sides are covered, it is necessary only to reverse the disk on the spindle to get a new surface, and experience has shown that emery cloth or paper are far more durable used in this way than would be expected to judge from their durability when used in the ordinary way; in fact, we think paper (rather than cloth) is usually employed upon the machine, and found to be satisfactory in every way.

As will be perceived, the machines are very neat in design, have very large spindle bearings, and the columns are fitted up as cupboards for holding disks and appliances.

In the smaller or No. 2 machine the right-hand rest swings across the face of the disk, and is so formed that pieces of work laid upon it have two of their sides held at exact right angles to the face of the disk. The other rest is adjustable vertically, and to any desired angle. In the larger machine the left hand rest is the same, but the right-hand one slides across the face of the disk upon covered ways.

The boxes are lined with adjustable cast iron sleeves, and the spindles have endwise adjustment. The belt tension can be readily adjusted by means of the countershaft, which can be adjusted for this purpose. The machines are designed to do a large class of work usually done by files, and on page 2 we give reproductions of photographs of work finished on them. The builders are the Charles H. Besly & Co., 10 and 12 N. Canal street, Chicago, Ill.

The Armor Plate Frauds.

BY GUS. C. HENNING, M. E.

Very few readers of the AMERICAN MACHINIST are, perhaps, able to account for themselves in a satisfactory manner how the armor plate frauds, as recapitulated in the issue of September 6th, could have been perpetrated and continued without detection on the part of the Government inspectors; hence it may interest them to have some explanation from one "who has been there," and his views as to how they could have been prevented. And, as the Committee on Naval Affairs, H. R. has clearly defined the shortcomings after a most thorough and careful investigation, there can be no doubt as to the facts as to what was done, or left undone.

It must be prefaced for the uninitiated that the Government inspectors have access to all parts of the works at all times; that the books of the works are open to them at all times, and that they are supposed to be on duty continuously during any and all operations. Also, that they should make the tests personally and keep their own records of all work.

The contractors, on the other hand, assume to do all the work, merely permitting the inspectors to stand by (look on from a distance, so to speak), generally considering it an impertinence on the part of the inspectors if they do more than this, by actually supervising the work in all details and compelling comparison and rectification of all mill records with their own. Suggestions on the part of inspectors as to methods of tests or of inspection are rarely, if ever, accepted by the management, and criticism of the same on the part of an inspector generally causes him to be relieved from duty through roundabout (generally political) influences, exerted by the management through Congressional or departmental friends. The inspector rarely having an opportunity or being called upon to explain or justify his action, the management characterizes his behavior as "fussy"; his rulings as "incompetent," and his request for rectification of errors or improvement of quality as too "exacting," and lay all blame for delay at his feet.

Government inspectors never make tests personally, but only do the clerical work of noting down results as stated to them by clerks or assistants paid by the contractor. They rarely recognize that they must keep detailed records of all steps, processes and materials; they do not often study the operations of a works so as to know the capacity of each and every department from their own observation. They also generally accept as correct all information imparted, instead of examining each and every statement as to its accuracy. Instead of assuming that everything is correct and truthful, they should invariably satisfy themselves by personal investigation that no error has been committed; and this on the ground that humanity is fallible, and not on the assumption that fraud is intended. In this there can be no reflection on the character or intentions of the contractor, but it is the first requisite of a competent inspector, whose sole duty it is to *know* that everything is correct.

The capacity of reheating furnaces was insufficient, hence as it was known how many plates were to be treated, and also the necessary duration of treatment prescribed for each plate, a mere addition of the total number of hours, as reported by the mill clerk, should have shown at once that the days in the tempering department at Homestead had more than 36 hours as against 24 in the rest of the universe. Treating a part only of a plate would not interfere with the operations of treating plates, because, while a plate which did not completely fill a furnace, was undergoing treatment, a part of another plate could be placed in the same furnace, occupying the empty space, the remainder projecting from the furnace. The space left open between the plate and side of furnace would be tightly sealed by packing it with fire-brick and clay. Of course, a mere glance at a furnace would reveal such operations; but at the time when this was going on the inspectors were either in bed or enjoying the comforts of a club house, established for their particular benefit. False reports of treatment were possible because inspectors did not keep a record and watch the process continuously, and were not on hand at all times, to see whether plates were treated as a whole or in parts. Failure to treat bolts twice was not detected because inspectors did not know the capacity of furnaces, and were on hand but a part of each day. Previous stretching of test pieces was not detected, because the specifications require but an incomplete test, and the Navy Department alone is to blame for this; a complete and exact test will show whether a bar has been previously strained beyond the elastic limit or not. False specimens taken from other plates could not have been substituted, had the inspectors marked the plates personally, and kept their stamps in their own possession, instead of permitting employes of the contractor to mark either test coupons or finished work. Government inspectors allow this to be done as otherwise their hands and clothes would be soiled, and it would necessitate carrying some tools in their pockets. Manipulation of the testing machine could have been avoided, either by the inspector making the tests personally, or, better still, by the Government insisting upon the use of Emery testing machines, which cannot by any manner of means be tampered with, and provided the inspectors verify the machine in the first place, instead of assuming its accuracy.

Test pieces could not have been retreated before test if the inspectors had invariably retained their stamps in their own possession. It would lead too far to explain why this would prevent this fraud, but it is the remedy. Plates selected by the inspectors for ballistic test could not have been retreated without detection if they had been re-inspected on the cars immediately before shipment from the works, and upon arrival at the proving grounds. A second stamp would have been necessary to prevent retreatment or substitution.

False gauges were used for bolts, only because the inspector assumed that a gauge was correct, instead of satisfying himself by careful and frequent measurement that the tool handed to him by the employe was the correct gauge, or had not been changed by being accidentally bent and restraightened.

The incentives to commit all these frauds were, no doubt, three, viz: To increase profit, to increase output or expedite work, and last but not least, "just to fool the inspectors."

Retreating one plate selected for ballistic test would produce such improvement as to earn the premium allowed by contract on the entire lot which this plate represented; hence, instead of producing the best quality the premium was obtained while yet saving the cost of labor required to treat the entire lot added to the interest on the plant involved. Also, as furnace capacity was limited, proper treatment of all plates would have limited the capacity of the entire works; but instead of providing more furnaces at a comparatively small cost the specified treatment was simply omitted.

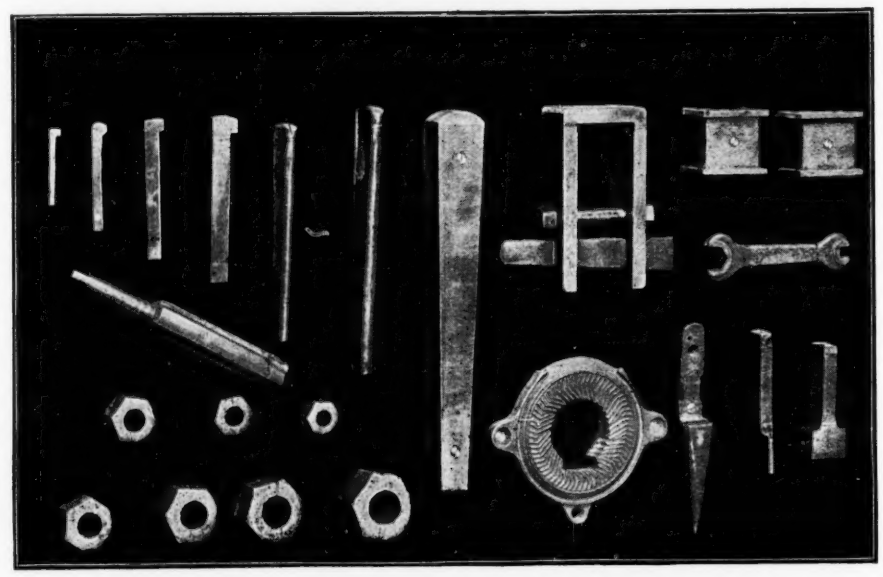
Substituting test pieces, cut from previously accepted plates, reduced the quantity of material rejected and hence increased output and profit. With proper precautions test pieces could not have been retreated without detection, if the inspectors had performed all their duties, and not alone those which are clearly prescribed by the departmental rules and regulations.

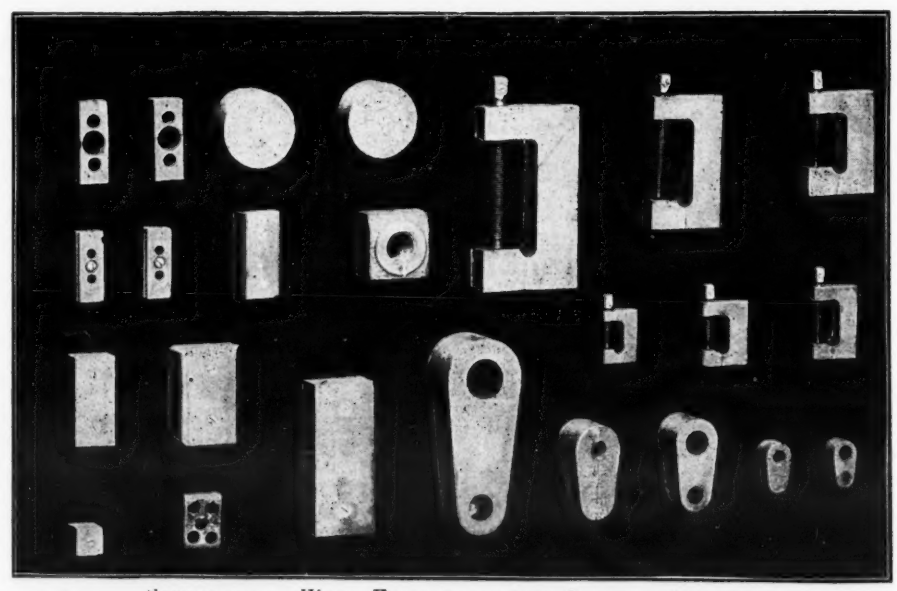
The fundamental cause of all the frauds is to be found in the principle of some steel manufacturers that the presence of an inspector relieves the works of all responsibility as to quality, and that they are justified in making just the very lowest grade of material which the inspectors will accept. Of course, this principle makes quality a direct function of the experience and knowledge of the inspectors, and as those detailed to the works at Homestead were notoriously inexperienced, trustful and easy going, the Navy Department is largely responsible that such frauds could have been committed.

Moreover, all navy officers of lower grades must act strictly in accordance with departmental orders, and such as are issued by their superiors and hence are left without discretion; without which no inspector can fulfill his duties in a correct or satisfactory manner. As long as the Navy Department details officers or men to inspection duty, who have not had great experience with contractors of various kinds, and as inspectors, it must expect frauds to be committed in contract work.

There is no lack of good material in the navy for this purpose, but it is to be found in the engineering branch of the service, and not among the officers of the line. If engineer officers cannot be spared for this service, the Secretary of the Navy has ample power to appoint civilians who have made inspection a specialty and are sure to give satisfaction.

Unless a contractor lays down the rule, as was heretofore always the rule at the Bethlehem Iron Co.'s Works, not to allow a single piece which is doubtful or slightly defective to leave the works, frauds will occur. Reputation for probity, honesty of purpose and quality of product should always be the first aims of our industrial establishments, and it pays best in the course of years.





SPECIMENS OF WORK FINISHED ON THE GARDNER GRINDER.

Comparison of Different Formulæ for Dimensions of Parts of Steam Engines.—V.

BY WILLIAM KENT, M. E.

Mr. Coffey gives as an example of improper dimensions the fly-wheel shaft of a 1,500 horse-power engine at Willimantic, Conn., which broke while the engine was running at 425 horse-power. The shaft was 17 feet 5 inches long between centers of bearings, 18 inches diameter for 8 feet in the middle, and 15 inches diameter for the remainder, including the bearings. It broke at the base of the fillet connecting the two large diameters, or 56½ inches from the center of the bearing. He calculates the mean torsional moment to be 446,654 inch-pounds, and the maximum at twice the mean; and the total weight on one bearing at 87,530 pounds, which, multiplied by 56½ inches gives 4,945,445 inch pounds bending moment at the fillet. Applying the formula $T_1 = B + \sqrt{B^2 + T^2}$, gives for equivalent twisting moment 9,971,045 inch pounds. Substituting this value in the formula $T_1 = .196\ S\ d^3$ gives for S the shearing strain 15,070 pounds per square inch, or if the metal had a shearing strength of 45,000 pounds, a factor of safety of only 3. Mr. Coffey considers that 6,000 pounds is all that should be allowed for S under these circumstances. If we take from Mr. Coffey's table a value of $.196\ S = 1{,}100$, we obtain $d^3 = 9{,}000$ nearly, or $d = 20.8$ inches, instead of 15 inches, the actual diameter.

Values of $S \times 196$.*

Ratio.	Heavy Sh'fts With Shock.			Light Shafts With Shock. Heavy Sh'fts No Shock.			Light Shafts No Shock.		
B to *T*	St'l	W. Ir'n	C. Ir'n	St'l	W. Ir'n	C Ir'n	St'l	W. Ir'n	C. Ir'n
3 to 10 or less	1045	880	440	1566	1320	660	2090	1760	880
3 to 5 or less	941	785	393	1410	1179	589	1882	1570	785
1 to 1 or less	855	715	358	1281	1074	537	1710	1430	715
B greater than *T*.	784	655	328	1176	984	492	1568	1310	655

Length of Shaft Bearings.—There is as great a difference of opinion among writers, and as great a variation in practice concerning length of journal bearings, as there is

[*This table should have appeared in our issue of September 20th, but was accidentally omitted.—ED.]

concerning crank pins. The length of a journal being determined from considerations of its heating, the observations concerning heating of crank pins apply also to shaft bearings, and the formulæ for length of crank pins to avoid heating may also be used, using for the total load upon the bearing the resultant of all the pressures brought upon it, by the pressure on the crank, by the weight of the fly wheel, and by the pull of the belt. After determining this pressure, however, we must resort to empirical values for the so called constants of the formulæ, really variables, which depend on the power of the bearing to carry away heat, and upon the quantity of heat generated, which latter depends on the pressure, on the number of square feet of rubbing surface passed over in a minute, and upon the coefficient of friction. This coefficient is an exceedingly variable quantity, ranging from .01 or less with perfectly polished journals, having end play, and lubricated by a pad or oil bath, to .10 or more with ordinary oil cup lubrication.

For shafts resisting torsion only, Marks gives for length of bearing $l = .0000247\, f\, p\, N\, D^2$, in which f is the coefficient of friction, p the mean pressure in pounds per square inch on the piston, N the number of single strokes per minute, and D the diameter of the piston. For shafts under the combined stress due to pressure on the crank pin, weight of fly wheel etc., he gives the following: Let Q = reaction at bearing due to weight, S = stress due steam pressure on piston, and R_1 = the resultant force; for horizontal engines, $R_1 = \sqrt{Q^2 + S^2}$, for vertical engines, $R_1 = Q + S$, when the pressure on the crank is in the same direction as the pressure of the shaft on its bearings, and $R_1 = Q - S$ when the steam pressure tends to lift the shaft from its bearings. Using empirical values for the work of friction per square inch of projected area, taken from dimensions of crank pins in marine vessels, he finds the formula for length of shaft journals, $l = .0000325\, f\, R_1\, N$, and recommends that to cover the defects of workmanship, neglect of oiling, and the introduction of dust, that f be taken at .16 or even greater. He says that 500 pounds per square inch of projected area may be allowed for steel or wrought iron shafts in brass bearings with good results if a less pressure is not attainable without inconvenience.

Whitham gives the same formula, with the coefficient .00002575, and says the length of the journal is from 1¼ to 1½ times the diameter of the shaft. This latter statement, however, is purely empirical, and is not based upon the formula, which is independent of the diameter of the shaft. Marks says that the use of empirical rules that do not take account of the number of turns per minute has resulted in bearings much too long for slow-speed engines and too short for high-speed engines.

Thurston ("Steam Engine Design," Part II., p. 117) says that the maximum allowable mean intensity of pressure may be, for all cases, computed by his formula for journals, $l = \frac{P\,V}{60{,}000 d}$, or by Rankine's, $l = \frac{P\,(V+20)}{44{,}800 d}$ in which P is the mean total pressure in pounds, V the velocity of rubbing surface in feet per minute, and d the diameter of the shaft in inches. It must be borne in mind, he says, that the friction work on the main bearing next the crank is the sum of that due the action of the piston on the pin, and that due that portion of the weight of wheel and shaft and of pull of the belt which is carried there. The outboard bearing carries practically only the latter two parts of the total. The crank shaft journals will be made longer on one side and, perhaps, shorter on the other, than that of the crank pin, in proportion to the work falling upon each, *i. e.*, to their respective products of mean total pressure, speed of rubbing surfaces and coefficients of friction.

Unwin says: Journals running at 150 revolutions per minute are often only one diameter long. Fan shafts running 1,500 revolutions per minute have journals six or eight diameters long. The ordinary empirical mode of proportioning the length of journals is to make the length proportional to the diameter, and to make the ratio of length to diameter increase with the speed. For wrought iron journals,

Revs. per min. = 50, 100, 150, 200, 250, 500, 1,000

$\frac{l}{d} = .004\, R + 1$

Length ÷ diam. = 1.2 1.4 1.6 1.8 2.0 3.0 5.0

Cast iron journals may have $\frac{l}{d} = \frac{9}{10}$ and steel journals $\frac{l}{d} = 1\frac{1}{2}$ of the above values.

Unwin gives the following, calculated from the formula $l = \frac{0.4\, H.\, P.}{r}$, in which r is the crank radius in inches, and $H\ P.$ the horse power transmitted to the crank pin.

THEORETICAL JOURNAL LENGTH IN INCHES

Loadon Journal in lbs.	Revolutions of Journal per minute.					
	50	100	200	3 0	500	1 000
1.000	.2	.4	.8	1 2	2.0	4.0
2,000	.4	.8	1.6	2.4	4.0	8 0
4,000	.8	1.6	3.2	4 8	8.0	16.0
5,000	1.0	2.	4.	6.	10	2).
10,000	2.	4	8.	12.	20.	40.
15,000	3.	6.	12.	18.	30.	...
20,000	4.	8.	16	24.	40.	...
30.000	6.	12.	24.	36.	.	...
40,000	8.	16.	32.	. .	...	...
50,000	10.	20.	40.	...	...	...

Applying these different formulæ to our six engines, we have

Engine No.	1		2		3		4		5		6	
Diam. cyl	...	10	....		....	30	. .		....	50	....	
Horse power	....	50	....		....	450	.		....	1,250	..	
Revs. per min	250	....	125		130	..	65		90	....	....	45
Mean press. on crank pin = S.	...	3,299	....		....	23,185	....		....	28,905	....	
Half wt. of fly wheel and shaft = Q.	268	....	536		5,968	....	11,936		26,470	....	52,940	
Resultant press. on bearing $\sqrt{Q^2 + S^2} = R_1$..	3,310	....	3,335		23,924	. . .	26,194		64 580	....	79,200	
Diam. of shaft journal	3 84	....	4.39		11 35	....	12 99		20.58	....	21 52	
Length of shaft journal:												
Marks, $l = .0000325\, f\, R_1\, N$ ($f = .10$)..	5.38	...	2 71		20.87	....	11.07		37.78	...	23 17	
Whitham, $l = .0000515\, f\, R_1\, R$ ($f = .10$).....	4.27	....	2 15		16 58	...	8 77		29.95	....	18 35	
Thurston, $l = \frac{P\,V}{60{,}000\, d}$	3 61	...	1 82		14 00	....	7 43		25 36	....	15 55	
Rankine, $l = \frac{P\,(V+20)}{44{,}800\, d}$	5.22	....	2.78		21 70	. .	10.85		35 16	....	22 47	
Unwin, $l = (.004\, R + 1)\, d$.....	7.68	....	6.59		17.25	....	16 36		27.99	. .	25 39	
Unwin, $l = \frac{0.4\, H.\, P.}{r}$	3.33	....	1 60		12.00	....	6 (0		20.83	. .	10.42	
Average.....	4 92	....	2.99		17 05	....	10 00		29.54	....	19 22	

If we divide the mean resultant pressure on the bearing by the projected area, that is, by the product of the diameter and length of the journal, using the greatest and smallest length out of the seven lengths for each journal given above, we obtain the pressure per square inch upon the bearing, as follows:

Engine No.	1	2	3	4	5	6
Pressure per sq. in., shortest journal.....	259	455	176	336	151	353
Pressure per sq. in., longest journal	112	115	97	123	83	145
Pressure per sq. in., average journal.....	175	254	124	202	106	191
Pressure per sq. in., journal of length = diam	..	173	....	155	...	175

Many of the formulæ give for the long-stroke engines a length of journal less than the diameter, but such short journals are rarely used in practice. The last line in the above table has been calculated on the supposition that the journals of the long-stroke engines are made of a length equal to the diameter.

In the dimensions of Corliss engines given by J B Stanwood, *Engineering*, June 12, 1891, the lengths of the journals for engines of diameter of cylinder 10 to 20 inches are the same as the diameter of the cylinder, and a little more than twice the diameter of the journal. For engines above 20 inches diameter of cylinder the ratio of length to diameter is decreased so that an engine of 30 inches diameter has a journal 26 inches long, its diameter being $14\frac{15}{16}$ inches. These lengths of journal are greater than those given by any of the formulæ above quoted.

There thus appears to be a hopeless confusion in the various formulæ for length of shaft journals, but this is no more than is to be expected from the variation in the coefficient of friction, and in the heat conducting power of journals in actual use, the coefficient varying from 10 (or even 16 as given by Marks) down to .01 according to the condition of the bearing surfaces and the efficiency of lubrication. Thurston's formula $l = \frac{P\,V}{60{,}000\, d}$ reduces to the form $l = .000004363\ P\ R$ in which P = mean total load on journal, and R = revolutions per minute. This is of the same form as Marks' and Whitham's formulæ, in which if f the coefficient of friction be taken at .10 the coefficients of $P\ R$ are, respectively, .0000065 and .00000515 Taking the mean of these three formulæ, we have $l = .0000053\ P\ R$, if $f = .10$ or $l = .000053\, f\, P\ R$ for any other value of f. The writer believes this to be as safe a formula as any for length of journals, with the limitation that if it brings a result of length of journal less than the diameter, then the length should be made equal to the diameter. Whenever with $f = .10$ it gives a length which is inconvenient or impossible of construction on account of limited space, then provision should be made to reduce the value of the coefficient of friction below .10 by means of forced lubrication, end play, etc., and to carry away the heat, as by water cooled journal boxes. The value of P should be taken as the resultant of the mean pressure on the crank, and the load brought on the bearing by the weight of the shaft, fly wheel, etc., as calculated by the formula already given, viz, $R_1 = \sqrt{Q^2 + S^2}$ for horizontal engines, and $R_1 = Q + S$ for vertical engines.

For our six engines the formula $l = .0000053\ P\ R$ gives, with the limitation for the long stroke engines that the length shall not be less than the diameter, the following:

Engine No	1	2	3	4	5	6
Length of journal...	4.33	4.39	16.48	12.99	31.80	21.52
Pressure per square inch on journal....	196	173	128	155	102	171

Crank Shafts with Center Crank and Double Crank Arms.—In center crank engines, one of the crank arms, and its adjoining journal, called the after journal, usually transmit the power of the engine to the work to be done, and the journal resists both twisting and bending moments, while the other journal is subjected to bending moment only. For the after crank journal the diameter should be calculated the same as for an overhung crank, using the formula for combined bending and twisting moment, $T_1 = B + \sqrt{B^2 + T^2}$, in which T_1 is the equivalent twisting moment, B the bending moment and T the twisting moment. This value of T_1 is to be used in the formula diameter $= \sqrt[3]{\frac{5.1\ T_1}{S}}$. The bending moment is taken as the maximum load on piston multiplied by one fourth of the length of the crank shaft between middle points of the two journal bearings, if the center crank is midway between the bearings, or by one half the distance measured parallel to the shaft from the middle of the crank pin to the middle of the after bearing. This supposes the crank shaft to be a beam loaded at its middle and supported at the ends, but Whitham would make the bending moment only one half of this, considering the shaft to be a beam secured or fixed at the ends, with a point of contra flexure one fourth of the length from the end. The first supposition is the safer, but since the bending moment will in any case be much less than the twisting moment, the resulting diameter will be but little greater than if Whitham's supposition is used. For the forward journal, which is subjected to bending moment only, diameter of shaft $= \sqrt[3]{\frac{10.2\ B}{S}}$, in which B is the maximum bending moment and S the safe shearing strength of the metal, per square inch.

For our six engines, assuming them to be center crank engines, and considering the crank shaft to be a beam supported at the ends and loaded in the middle, and assuming lengths between centers of shaft bearings as given below, we have:

Engine No.	1		2		3		4		5		6	
Length of shaft, assumed, inches L.	20	....	24		48	..	60		76	....	96	
Maximum pressure on crank pin P..	....	7,854	....		....	70,686	....		. ..	196,350	....	
Maximum bending moment $B = \frac{1}{4}\, P\, L$	39,270	....	49,637		848,232	....	1, 60,200		3,729,750	....	4,712,400	
Twisting moment T.....	47,124	....	94 248		1,060,290	....	2,120 580		4,712,400	.. ..	9,424,800	
Equiv. twisting moment $B + \sqrt{B^2 + T^2}$	101,000	...	156,000		2 208,000	...	3,420,000		9,740,000	....	15,240,000	
Diam. of after journal, $d = \sqrt[3]{\frac{5.1\ T_1}{8{,}000}}$	3.98	....	4.60		11.15	...	13.60		18. 5	...	21.20	
Diam. of forward journal, $d_1 = \sqrt[3]{\frac{10.2\ B}{8{,}000}}$	3.68	....	3.99		10.28	....	11.16		16.82	...	18.18	

The lengths of the journals would be calculated in the same manner as in the case of overhung cranks, by the formula $l = .000053\ f\ P\ R$, in which P is the resultant of the mean pressure due to pressure of steam on the piston, and the load of the fly wheel, shaft, etc., on each of the two bearings. Unless the pressures are equally divided between the two bearings, the calculated lengths of the two will be different, but it is usually customary to make them both of the same length, and in no case to make the length less than the diameter. The diameters also are usually made alike for the two journals, using the largest diameter found by calculation.

The crank pin for a center crank should be of the same length as for an overhung crank, since the length is determined from considerations of heating and not of strength. The diameter also will usually be the same, since it is made great enough to make the pressure per square inch on the projected area (product of length by diameter) small enough to allow of free lubrication, and the diameter so calculated will be greater than is required for strength.

Crank Shaft with Two Cranks Coupled at 90°.—If the whole power of the engine is transmitted through the after journal of the after crank shaft, the greatest twisting moment is equal to 1.414 times the maximum twisting moment due to the pressure on one of the crank pins. If T = the maximum twisting moment produced by the steam pressure on one of the pistons, then T_1 the maximum twisting moment on the after part of the crank shaft, and on the line shaft, produced when each crank makes an angle of 45° with the center line of the engine, is $1.414\ T$. Substituting this value in the formula for diameter to resist simple torsion, viz., $d = \sqrt[3]{\frac{5.1\ T}{S}}$, we have $d = \sqrt[3]{\frac{5.1 \times 1.414\ T}{S}}$, or $d = 1.932 \sqrt[3]{\frac{T}{S}}$, in which T is the maximum twisting moment produced by one of the pistons, d = diameter in inches, and S = safe working shear-

ing strength of the material. For the forward journal of the after crank, and the after journal of the forward crank, the torsional moment is that due to the pressure of steam on the forward piston only, and for the forward journal of the forward crank, if none of the power of the engine is transmitted through it, the torsional moment is zero, and its diameter is to be calculated for bending moment only.

For Combined Torsion and Flexure.—Let B_1 = bending moment on either journal of the forward crank due to maximum pressure on forward piston, B_2 = bending moment on either journal of the after crank due to maximum pressure on after piston, T_1 = maximum twisting moment on after journal of forward crank, and T_2 = maximum twisting moment on after journal of after crank due to pressure on the after piston.

Then equivalent twisting moment on after journal of forward crank $= B_1 + \sqrt{B_1^2 + T_1^2}$.

On forward journal of after crank $= B_2 + \sqrt{B_2^2 + T_1^2}$.

On after journal of after crank $= B_2 + \sqrt{B_2^2 + (T_1 + T_2)^2}$.

These values of equivalent twisting moment are to be used in the formula for diameter of journals $d = \sqrt[3]{\frac{5.1\ T}{S}}$. For the forward journal of the forward crank shaft $d = \sqrt[3]{\frac{10.2\ B_1}{S}}$.

It is customary to make the two journals of the forward crank of one diameter, viz., that calculated for the after journal.

For a three-cylinder engine with cranks at 120 degrees, the greatest twisting moment on the after part of the shaft, if the maximum pressures on the three pistons are equal, is equal to twice the maximum pressure on any one piston, and it takes place when two of the cranks make angles of 30 degrees with the center line, the third crank being at right angles to it. (For demonstration, see Whitham, "Steam Engine Design," page 252.) For combined torsion and flexure the same method as above given for two crank engines is adopted for the first two cranks, and for the third, or after crank, if all the power of the three cylinders is transmitted through it, we have the equivalent twisting moment on the forward journal $= B_3 + \sqrt{B_3^2 + (T_1 + T_2)^2}$, and on the after journal $= B_3 + \sqrt{B_3^2 + (T_1 + T_2 + T_3)^2}$, B_3 and T_3 being respectively the bending and twisting moments due to the pressure on the third piston.

Crank shafts for triple-expansion marine engines, according to an article in *The Engineer* (London) April 25, 1890, should be made larger than the formulæ would call for, in order to provide for the stresses due to the racing of the propeller in a sea way, which can scarcely be calculated. A kind of unwritten law has sprung up for fixing the size of a crank shaft, according to which the diameter of the shaft is made about 0.45 D, where D is the diameter of the high-pressure cylinder. This is for solid shafts. When the speeds are high, as in war ships, and the stroke short, the formula becomes 0.4 D, even for hollow shafts.

Get a Good Foundation.

We remember the instance of a machine tool that had been built and re-built, and it was never satisfactory in its operations. Then another took a hand in the matter, knocked off the unsatisfactory legs, and set the bed right down on a satisfactory foundation of masonry, and the whole thing was complete.

James M. Cremer, M. E., 170 Gates avenue, Brooklyn, N. Y., who was formerly connected with Henry R. Worthington, as purchasing agent and designer of special tools and machinery for manufacturing operations, is now doing a consulting business on the same lines.

A Few Examples in Patternmaking.

By John M. Richardson.

FITTING SPOTS AND BOSSES TO CURVED SURFACES.

There is much fitting done with blue chalk and a gouge, which is unnecessary, as well as being both tedious and expensive, and which in many cases can be dispensed with, as I shall try to demonstrate.

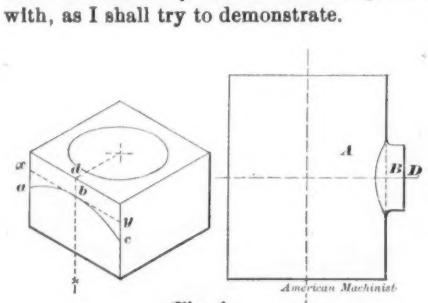


Fig. 1

Take the case shown at *A*, Fig. 1, which is a simple example of attaching a circular spot to a cylindrical surface.

There is no excuse for any cut and try method here.

Get out a block of parallel thickness, larger than the spot required, and exactly square on the four sides. On the under side, draw diagonals, and at their intersection bore a small hole, so that it can be accurately placed on the screw chuck. On the center of the top face strike a circle a little larger than the fillet at base of spot.

Now gauge a line $x\ y$ on one side, the thickness of the boss required, and with a radius equal to that of the cylinder, strike the arc $a\ b\ c$ tangent at the point b. Next, band saw carefully to the under side of this line, then place the two pieces together again, and put two or more fine brads within the circle, to hold the pieces together while turning. Now, band saw once more to the circle, or in very small cases somewhat larger, and place upon the screw chuck and turn. After the brads are removed, the piece will be a perfect fit for the cylinder, and can at once be attached.

When a fillet is turned on the spot, the two opposite sides or flaps will sometimes need a little trimming after the piece has

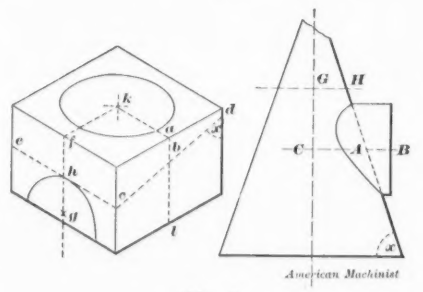


Fig. 2

been glued on, owing to the curvature of the cylinder.

It quite rarely becomes necessary to fit a turned boss to a conical surface, but it can also be done similarly on the band saw, but the fillet will have to be dispensed with in the lathe, and added afterwards.

First get out a block precisely as in the other case, and center it for the screw chuck in the same manner. Next, center the top side, and describe a circle somewhat larger than the spot, for a guide in band sawing, then draw the lines $k\ a$, $a\ l$, $k\ f$, $f\ g$, Fig. 2, with either the gauge or try square.

Lay off the distance $a\ b$ on the block equal to $A\ B$ on the cone, and through the point b draw the line $c\ d$, making the angle x = the angle X on the cone, and draw $e\ e$ parallel with the top face of block. The distance $C\ G$ on the axis of the cone must equal $f\ k$ on the block, and now, with the radius $G\ H$ describe the arc upon the block tangent to the line $e\ e$ at the point h, and saw to the inner side of this curve, first remembering to tilt the saw table, so that the blade will match the line $c\ d$. After the block is sawed, fasten the pieces together with brads within the circle, and saw to the circle, or a little outside of it, and then place in the lathe, and turn as if the piece was solid.

After the brads are removed the boss will fit the cone perfectly at the height required, but nowhere either above or below the desired position.

CORE BOXES.

Small frame core boxes, of which *A B C*, Fig. 3, are examples, are very commonly used to produce cores for holes in bed castings for various kinds of machinery, and in very many other places.

The figure just referred to shows an expeditious way of making them. Simply plane a board to the thickness required, and lay out the outline on the middle of its surface, remembering to have the width the thickness of the saw kerf in excess of what is required, and in case of circular arcs, as at *B* and *C*, Fig. 2, use two centers, the width of the saw apart, so that the box will have a true curve when finished. Then saw the box open on the lines indicated in Fig. 3, commencing at one end, passing through what is to be the opening, and out at the other end. This separates the piece, so that the remaining lines can be readily followed, and the wavy or scalloped lines at the ends do away with all necessity of dowel pins, which are liable sometimes to give trouble by sticking.

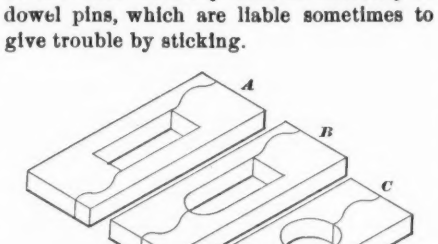


Fig. 3

Boxes of this kind are the simplest kind of core boxes, and are applicable for cores of varying shapes, having straight sides, and they should be made *entirely* on the band saw, for if a band saw is kept in perfect condition, it needs only sand paper for the finishing touches, if the lines have been followed as they should be.

TO MAKE A T-CORE BOX.

An expeditious way of making a core box for a T slot is as follows:

Take, for example, the one shown at Fig. 4 at *A*, which is 2 inches from the top of the print to the bottom of the T, and $\frac{3}{4}$ inch wide at the narrowest part, and $1\frac{1}{2}$ inches at the widest.

First get out a piece of stuff 2 inches in thickness, and of convenient width, being a little longer than the sum of both sides plus the ends. Next, cut off two pieces exactly $1\frac{1}{2}$ inches long, and save them for ends. Now rabbet one corner of the remaining strip $\frac{3}{8}$ inch wide and $\frac{3}{4}$ inch deep, as shown at *B*, Fig. 4, and saw the piece in halves, laying off a distance x equal to the length of core on each piece, and then cut out the part outside the lines at both ends and back to the surface *D*. Nail one end piece against the shoulder thus formed on both side pieces, and they will be like the half box in Fig. 4.

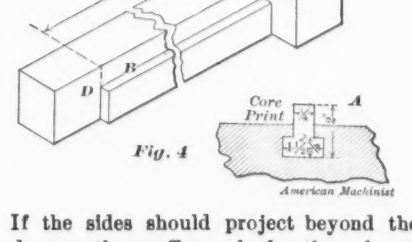


Fig. 4

If the sides should project beyond the ends, saw them off evenly for the sake of looks, and the core box is done except finishing.

By working closely to the lines, the whole job should be done entirely with the circular and band saw, needing no finish previous to varnishing with shellac, except sand paper, and dowel pins can be dispensed with as each half of the box comes together against a shoulder.

What is a Chronometer?

Under the above heading a writer who signs himself J. L. contributes to the *English Mechanic* a very interesting account of the origin of temperature compensation in clocks and watches. He writes as follows:

"Under the above heading 'A Seeker After Truth' asks what is the difference between a watch and a chronometer? Well, the difference is in the construction of the balance. What the pendulum is to a common clock the balance and main spring are to a common watch. This spring, like the pendulum, is affected by different degrees of heat or cold, which causes it to expand or contract, as the case may be, and the rate of going is, in consequence, sensibly altered. It is the method of adjusting this variation and establishing uniformity in the speed that constitutes the difference between an ordinary watch and a chronometer. A brief sketch of John Harrison and his invention will enable 'Seeker After Truth' to see how this was accomplished. Before Harrison applied himself to the matter, the problem of how to counteract the effect of temperature on the pendulum of a clock and insure a regular rate of going had not been solved, though something had been accomplished by Huygens, and also by Graham with his mercurial pendulum. Taking various metals and submitting them to similar alterations of temperature, Harrison found that they did not expand or contract in the same degree. He therefore constructed a pendulum formed of parallel bars of iron and brass, so arranged that the different degrees of expansion or contraction of the two metals counteracted each other, leaving the center of oscillation unaffected. In 1726 he had completed and tested his invention practically, and found it a complete success. Elated by his achievement, and probably influenced by the reward of £20,000 which, twelve years previously, the English government had offered for a method of determining longitude at sea, Harrison had the clock put on to a vessel for the purpose of testing it under other conditions; but the irregular motion of the ship greatly interfered with its accuracy.

"He found he must alter the prime mover from a pendulum to a wind up spring and compensating balance. By 1728 he had completed his drawings, and proceeded to London to solicit pecuniary assistance to enable him to construct his new chronometer. In this he was unsuccessful, so that he was obliged to work at his invention during his leisure time. It took him seven years to complete, and on several occasions when tried in a large barge on the river Humber, in all kinds of weather, it went perfectly, without losing any time. Describing the arrangement of the machine, Harrison said he made use of two balances situated in the same plane, but vibrating in contrary directions, so that the one of these being either way assisted by the tossing of the ship, the other might constantly be just so much impeded by it at the same time. To secure equality of the times of the vibrations of the two balances, he introduced four cylindrical springs or worms applied near their upper and lower extremities. He also introduced and applied the principle of his compensation pendulum to the balance to regulate the effects of the temperature on the spring. His 'thermometer kirb,' he himself says, 'is composed of two thin plates of brass and steel, riveted together in several places, which, by the greater expansion of brass than steel by heat and contraction by cold, becomes convex on the brass side in hot weather and convex on the steel side in cold weather, whence, one end being fixed, the other end obtains a motion corresponding with the changes of heat and cold, and the two pins at the end, between which the balance-spring passes, and which it alternately touches as the spring bends and unbends itself, will shorten or lengthen the spring, as the change of heat or cold would otherwise require to be done by hand in the manner used for regulating a common

watch.' He also introduced a secondary mainspring to keep the chronometer going while the mainspring was being wound up, so that not a second was lost.

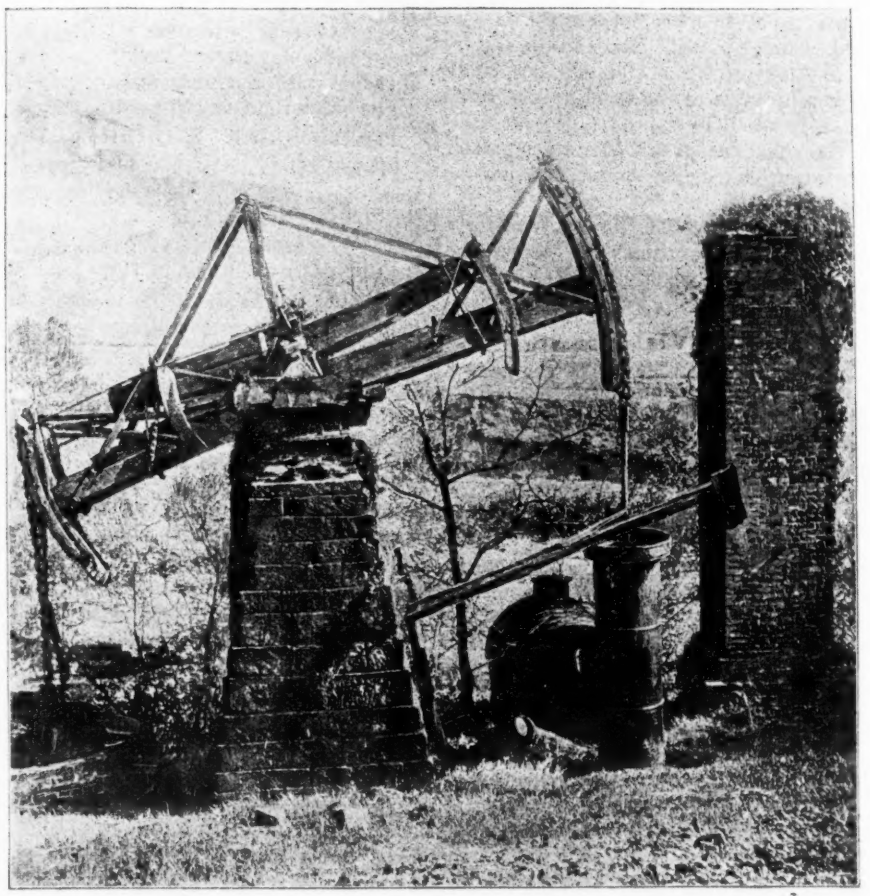
"In 1735 we again find Harrison in London—this time with his chronometer—in order to submit it to the Commissioners of Longitude. These gentlemen were empowered by Act of Parliament to offer rewards to any inventor who should construct a machine fulfilling these conditions—£10,000 if it determines the said longitude to 1 degree of a great circle, or 60 miles, £15,000 if it determines it to two thirds of that distance, £20,000 if it determines it to half that distance. Harrison received permission to take his machine on board a man of war, and go with it to Lisbon and back. The roughest weather did not affect it, and the trial was perfectly satisfactory. The Commissioners awarded £500 to Harrison subject to his promise to further improve the machine, one condition being that it should occupy less space. He finished the second machine in 1739, diminished the size one-half, and reduced the number of wheels. This machine answered even better than the first, and fully met the strictest requirements of the Act. He then set to work to make a third machine of still smaller size, which occupied, with all its apparatus, an area of only 4 square feet. The Commissioners, in 1741, made him a grant of £500, and in 1746 another £500, to assist him in finishing his third machine, which task he accomplished in 1749. He then proceeded to make a fourth machine, about 5 inches in diameter, but, considering his third machine capable of satisfying all requirements, applied to the Commissioners for permission to have it tried on some ship bound for the West Indies. This, however, was not granted until 1761, and as by this time he had completed his fourth machine in the form of a watch, his son William set sail with this one from Portsmouth for Jamaica in a man-of-war, and was away from England from November 18, 1761, to March 26, 1762. He returned to Portsmouth in another vessel, and in the voyage of four months it had varied only 1 minute 54½ seconds, or about 18 geographical miles. Before awarding the prize the Commissioners required a second trial, which took place two years later, when, in a four months' voyage to the Barbadoes, the instrument varied only to the extent of about one half of that of the previous trial. In 1765 the Commissioners granted Harrison the £20,000 on the following conditions: One half upon discovering the principles of the construction of his chronometers and assigning his four chronometers to the use of the public, and the other half on sufficient proof of their correctness. He ultimately received the whole reward, and his fourth chronometer, along with an exact copy of it made by one of his apprentices, and used by Captain Cook on his voyage round the world, are, I believe, still to be seen at the Royal Observatory, Greenwich."

We should add to this, however, that Harrison's method of compensation for watches is not now used, and it was, in fact, not satisfactory to himself. He suggested that it would be better to make the compensation in the balance wheel as is now the practice. Harrison was originally a carpenter, but became the foremost chronometer maker of his time.

Regarding the unconsciously humorous description of "A New Steam Trap," which we reprinted in our issue of October 4th from the columns of a contemporary, the plot thickens, so to speak, our English contemporary, *The Practical Engineer*, in its issue of October 5th, calling attention to the fact that the description, in which the curious substitution of "board and spring" was made for bourdon spring, first appeared in its own columns, was due to "a somewhat stupid clerical error, committed in dictation," and was then widely copied by its contemporaries, who failed to notice the very ludicrous mistake.

An Existing Newcomen Steam Engine.

The steam engine has long ago attained the dignity of having a history, and, indeed, an ancient history. It is to be found in museums and collections, and already many controversies have been waged over most points in its early construction. Attempts have been made, by aid of engravings and drawings, to reconstruct some of the earlier examples, so as to give the present generation a vivid idea of the triumphs of some of the great mechanical minds long passed away. Valuable as these full sized models are, they, nevertheless, lack actuality, and there is always a doubt in the mind of the spectator of their literal accuracy. Far better it is when an actual example can be secured, and preserved for posterity. At the present moment there is a specimen of an engine built by Newcomen, of Dartmouth, in 1705, rusting away in the open air for want of a friendly hand being put forth for its preservation. It was brought to our notice by Mr. Bryan Donkin, to whom its existence was disclosed by Mr Samuel Fletcher, of Ashton-under-Lyne, and we have pleasure in presenting



An Existing Newcomen Engine.

our readers with an engraving showing its condition a year ago (since then the beam has fallen over).

For years the engine was looked upon as one of James Watt's first productions, but recent inquiries leave no doubt that it is a steam motor of the Newcomen pumping type, single acting. Nothing is known at all trustworthy as to its history. There are a few old residents in the neighborhood who remember its being occasionally, though not regularly, worked some 60 or 70 years ago (1834) for pumping a mine, about which time it seems to have been allowed to fall into disuse. The date of its erection in Fairbottom Valley, halfway between Ashton under Lyne and Oldham, is uncertain, but it was probably towards the end of last century. It is still on the original site. The engine consists of a solid masonry pillar, 14 feet 6 inches by 7 feet 3 inches at the bottom, carrying the beam, which is made of oak, 12 inches by 14 inches, braced together with iron, and has segmental ends with the balance-weight at one extremity and the piston at the other. The beam, about 20 feet long, rocks on two trunnions resting on the central masonry pillar, and the piston and pump rods are attached to it by chains. The cylinder, of cast iron, is about 27⅝ inches in diameter and about 6 feet stroke, the steam entering only at the bottom. It is cast in one piece, 8 feet 9 inches from flange to flange, and about 1¼ inches thick. As there was no separate condenser, condensation was effected by injecting water into the cylinder by a motion from the beam. It is impossible to say whether there were any rings round the piston, as it has not been taken apart, but probably there were none. A method often employed for keeping the joint of the piston good was to place horse dung on the top, but other materials that retained moisture, such as turf or tow, were also used. The valve gear was off a few years ago, and the pieces were lying about, but they probably could be collected. The wrought-iron boiler, of the wagon type, is in a very bad condition; it is believed to be of a more recent date than the engine, and that the original was a haystack generator.

The width of the boiler is 6 feet 3 inches at the widest part, and 5 feet 7 inches at the narrowest, the height being 7 feet. There is a steam dome 18 inches in diameter by 14 inches deep, with an 8-inch steam pipe leading vertically out of it. There are five plates in the circumference of the boiler, and 12 rings of plates in its length, the average size of plate being 19 inches by 3 feet 6 inches. The present thickness of the plates varies from $\frac{5}{16}$ inch to zero. The pitch of the rivets is 1¼ inches to 2 inches.

It appears probable that this is the oldest engine in existence, but it is in a most dilapidated state. Having been so long exposed uncovered to all weathers, the beam has nearly fallen on its side, and the boiler is worn away till it is no thicker than paper in parts, with many holes. The grievous condition of neglect and disrepair into which the engine has fallen is an object of much concern to the people in the neighborhood, who would gladly co operate in efforts to save it from rot, rust and total destruction. The engine is the property of the trustees of the late Earl of Stamford and Warrington.

Any suggestion for the safe preservation of this interesting old relic will be gladly received by Mr. S. Fletcher or Mr. Bryan Donkin. These gentlemen are anxious to find a home for an object of such importance to the history of the steam engine. The above dimensions were taken personally by them during a visit to the spot about two months ago.—*Engineering* (London).

Mr. Geo. Simpson, who was formerly with the Robert Pool & Son Co., Baltimore, is now superintendent of the Farrel Foundry and Machine Co., Ansonia, Conn.

Ruskin's Apotheosis to the Locomotive.

"I cannot express the amazed awe, the crushed humility, with which I sometimes watch a locomotive take its breath at a railway station, and think what work there is in its bars and wheels, and what manner of men they must be who dig brown ironstone out of the ground and forge it into that! What assemblage of accurate and mighty faculties in them; more than fleshly power over melting crag and coiling fire, fettered and finessed at last into the precision of watch making; Titanian hammer strokes, beating out of lava these glittering cylinders, and timely respondent valves, and fine-ribbed rods, which touch each other as a serpent writhes in noiseless gliding, and omnipotence of grasp; infinitely complex anatomy of active steel, compared with which the skeleton of a living creature would seem, to a careless observer, clumsy and vile—a mere morbid secretion and phosphatous prop of flesh. What would the men who thought out this, who beat it out, who touched it into its polished calm of power, who set it to its appointed task, and triumphantly saw it fulfill this task to the utmost of their will, feel or think about this weak hand of mine, timidly leading a little strain of water color which I cannot manage, into an imperfect shadow of something else—mere failure in every motion, and endless disappointment? What, I repeat, would these iron-dominant genii think of me, and what ought I to think of them?"

LETTERS FROM PRACTICAL MEN.

Inventive Problems.

Editor American Machinist:

Ever since Chordal made sport out of my struggles with the time keeper, I have taken a lively interest in everything that bears upon the subject of mechanical movements. Hence the problems offered by Mr. Allen and Mr. Oberlin Smith, together with the various solutions which you have published, have been of special interest to me. These questions undoubtedly excite a general interest. The practical man who is looking for something of utility, the student to increase his store of knowledge, and others, perhaps, by the puzzling element they contain, much as chess problems attract those devoted to that science.

It would seem to the casual observer that some of these problems, and the solutions given, were open to severe criticism. As Chordal would say, they are not "orthodox." But it must be borne in mind that in mechanics, as well as creeds, circumstances alter cases, and that which would have been rejected a few years ago, may be accepted now. When we look around there is no scarcity of examples of this kind. It would be about as absurd for a person to assume a censorship over such matters, as for the patent examiner to attempt to say which is, and which is not, a meritorious invention.

Some might say of one of the first problems proposed by Mr. Allen: What use can there be for anything better than belts or gearing for transmitting motion from one shaft to another? Why substitute a lot of levers and bell cranks?

In answering these questions, I need only refer to a somewhat recent invention which takes the place of miter wheels in transmitting motion from one shaft to another. The well known objections to gearing, or the mule stand, have created a demand for something better, and inventive genius has supplied it. The contrivance might be called a compound toggle joint, and has more motions in it than a pleased dog can give to his tail. Still the practical person needing such a thing will not analyze these movements, or stop to inquire whether or not they are orthodox. It is enough for him to know that it meets the intended requirements, and he adopts it.

The above example does not argue that improved mechanical movements are tending toward greater complication. The reverse of this I think is true. In the pell-mell rush that has gone on for the last 50 years in mechanical invention, it is not

surprising that the designer should often come far short of securing the best and simplest means for the accomplishment of his purposes.

The modern printing press, and indeed all lines of improved machinery, differ from the old chiefly by being more simple in construction One shaft is made to do duty for two. Rotary motion takes the place of reciprocating, one bolt serves for two, and often to the detriment of the machine, one pound of metal serves for two.

For the encouragement of those who are cultivating the inventive capacity, it may be said there is no danger of exhausting the ground, nor must we suppose all our cunningly devised schemes have come to stay. The search for improvement must go on, nor will it be confined to the higher realms of mechanic arts.

The movements and mechanisms for catching rats and mice have long been established in the wire loop and the steel trap, yet who knows but that eventually all this spring power may be supplied by compressed air. The only trouble I can see in it, would be that the air would likely get away, if the rats did not.

I might say here that I think the use of springs should be avoided as much as possible in all sorts of machinery. They may do to shut a gate, but even for this the gravity plan is better.

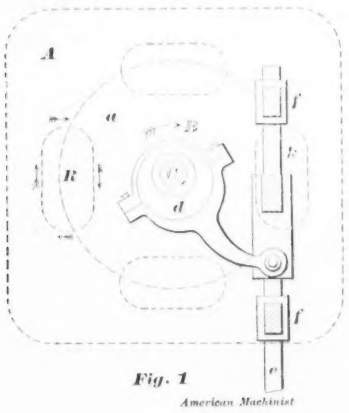
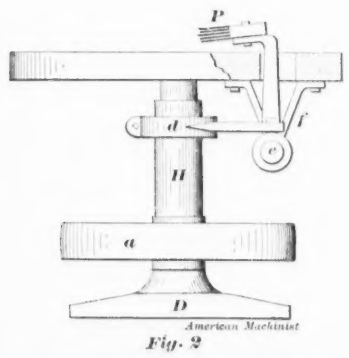


Fig. 1
American Machinist



American Machinist
Fig. 2

I worked out two or three schemes for Mr. Oberlin Smith's brush problem, but they contained springs, and I abandoned them. One plan which I think would work well, would be to actuate the brushes by means of eccentrics attached to the hub of the driving pulley. These may revolve on the center post to which the table attaches. Each brush may have its own yoke, on this eccentric. The brushes attach to arms which extend through the slots in the table, and the lower end of the arms fastened to a rock shaft, this gives the curved motion to the brush as described by Mr. Smith. The rock shaft is free to move endwise to the extent of the eccentrics' throw, which is 2 inches. The eccentric rod engaging with the rock shaft at an angle, and slightly above its center, causes the shaft to rock to the extent of the room allowed where the brush arm passes through the table, this motion I believe is stated as ⅜ inch. The two short motions taking place at the extremes of the 2 inch movement.

Herewith is a sketch of the plan and elevation of my scheme. In Fig. 1 the table *A* is shown by dotted lines. The shaft *c* connects this table with the base plate *D*, Fig. 2. On the shaft *c* revolves the pulley *a* with its long sleeve hub *H*, on which eccentrics are attached for actuating each brush; one of these is shown at *d*. The yoke of this eccentric attaches to the sliding rock shaft *c* at *o*, and at a sufficient angle to rock the shaft to the limit of the slot *K*, and at same time move the shaft and brush *P* lengthwise to the extent of the eccentrics' throw. In order that the brush *P* may follow the path as shown by arrows at *R*, the eccentric must revolve as shown at *B*. The rock shaft *e* is supported by hangers *F*, the near one being removed in Fig. 2. By adjusting eccentrics the motion of brushes may be made synchronous. "Quirk."

A Vibrating Water Fall.

Editor American Machinist:

The article entitled "A Vibrating Water Fall," by Wm. Sangster, in your issue of 11th inst., is interesting, and I hope someone will be able to explain the cause of this vibration due to water falling over a dam. I think Mr. Sangster's theory about vibrations being due to alternate logs and spaces in the dam is entirely erroneous, and that planking the perpendicular portion of the dam would do no good whatever. My reason for thinking so is that we have here a *stone* dam with *smooth stone face*, which at times gives the same kind of vibrations as Mr. Sangster refers to. I have known a house, probably 1,000 feet from the dam, to shake enough to rattle dishes on the shelves from this cause. The vibrations occur only at certain stages of the water, but at times are very strong.

The vibrations are felt at a much greater distance from the dam in certain directions than in others.

I have observed this phenomenon for a dozen years, but am unable to discover the exact cause, and would like to be enlightened. William Hill.

Collinsville, Conn.

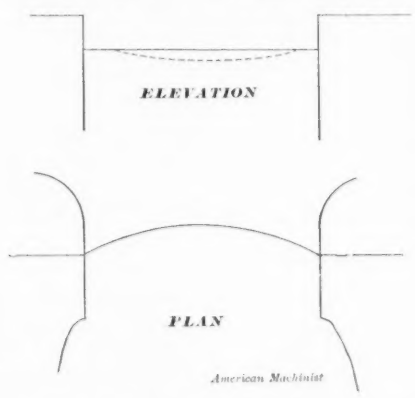
Vibrating Water Fall.

Editor American Machinist:

Mr. Robert D. Kinney has an article in your issue of October 11th of a vibrating water fall.

This is a common kind and very troublesome, as some large dams with large volumes of water become destructive in their effects.

I send in this a sketch of an elevation and plan of a dam that shook windows and doors for a space of one eighth of a mile.



American Machinist

After it had been up a few years, the mill above made a successful claim that it was too high, and they must lower it six inches.

It was a stone dam, and it was cut down as shown by the dotted lines, and after this was done there was no more trouble from vibration.

The theory is this: When a volume of water flowing over a dam is confined at the sides, the air enclosed back of the water becomes a drum under tension. Allowing ventilation from either side will stop all effects. W. E. Crane.

Section Liner.

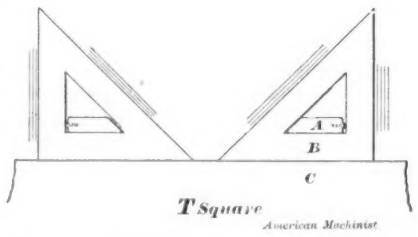
Editor American Machinist:

In issue of October 4th, Mr. F. R Honey brings out a new section liner, similar to one used by the writer since 1876, but with a few additions.

It has been a weakness with me to cast off unnecessary parts in drawing paraphernalia, as well as in machine construction.

In looking around for a section liner that could be used with all angles, I found the market wanting.

I went to the pattern shop, cut out a piece of hard wood as *A*, as much shorter than the space in the angles, 45°, 60° and 30°, as the largest space wanted between lines on the drawing; inserted a screw at the square end to screw out to shorten the space for finer section lining, and had a section liner that covered a larger field than one offered me for $10.



American Machinist

It is not necessary to have the piece *A* the same thickness as the angle, but thin enough to let the head of the screw down to perform its part.

Then divide the left hand in three parts, the two small fingers resting on *A*, the two long fingers resting on angle *B*, and the thumb and ball of the hand resting on and holding the tee-square blade *C* in place. The operator is ready to work right-handed, or *vice versa* for left hand. With five minutes' practice he is familiar with the movement, and a day section lining makes him an adept with the tool, and he can use angles either right or left hand.

Port Huron, Mich. Hale G. Robinson.

[This is an old device, but may be new to some of our readers.—Ed.]

Baling Shavings.

Editor American Machinist:

I would advise E. P. H. to get a hay baling press such as hay dealers use to bale cut hay. He can bale shavings, sawdust and small bits of wood. E. K. K.

A Wonderful Cupola.

Editor American Machinist:

Referring to the comments, pro and con, relating to "the wonderful cupola," it would seem to me your judgment is about correct, *i. e.*, that it is a wonderful cupola, because, revising Mr. Durfee's calculation, wherein he has overlooked the latent heat of fusion, we have

$$\frac{14{,}544 \times .85 \text{ per cent.}}{(2{,}140 \times 0.12983) + 233} = 24.2 \text{ pounds of}$$

iron theoretically melted per pound of coke. Now, the cupola in practice melts, it is stated, 22.2 pounds of iron per pound of coke, hence its efficiency is $\frac{22.2}{24.2} = 91.73$ per cent. Truly, it is a wonderful cupola in view of the fact that heat lost by radiation and by connection of its waste gases, has not been taken into account in the above calculation. It is "a mystery." Robt. D. Kinney.

Philadelphia, Pa.

Editor American Machinist:

If Mr. Durfee will glance over his calculation of the theoretical quantity of coke or carbon needed to melt a pound of iron, he will see that he has inadvertently omitted to take into account the heat required to *melt* the iron, aside from that required to raise the temperature to the melting point. To introduce this factor he would need the latent heat of fusion of cast iron (average). I know of no experimental determinations of this constant, but it can be calculated by a method given by Person, with a fair degree of accuracy, *i. e.*, within 10 per cent. or so. I have run through the calculation of the theoretical quantity of fuel needed for a pound of iron, using a value for the latent heat of fusion of cast iron, obtained by Person's formula. The result will only be approximate, as several of the factors are only roughly known. The melting point of "cast iron" is given by different writers, all the way from 1,100° to 1,500° Centigrade. Cast-iron of average quality probably melts at about 1,300°, and this will be taken as the basis of calculation.

The specific heat of cast iron varies with the temperature, being about 0.129 at temperatures near 100° and 0.167 at 2,000°. The mean specific heat between 16° (ordinary temperature) and 2,000° may be taken as 0.148.

The latent heat of fusion of average cast-iron, as I have calculated it, is about 59. calorics. The heat of combustion of carbon (burning to carbonic acid) is 8,080 (metric units).

One ton, or 2,240 pounds, equals 1,018 kilograms. To melt this quantity of cast-iron would take, assuming that we start with the iron at 16°, or the ordinary temperature,

$$\frac{1{,}018\,(1{,}300 - 16) \times .148 + 1{,}018 \times 59}{8{,}080 \times .85} =$$

44. + kilograms coke.

Then the ratio between the coke used and iron melted is as 1 to 23.

At present I can see no flaw in this calculation though I am entirely open to conviction.

As to the duty of cupolas in ordinary foundries the ratio ordinarily runs at about 1 : 8 for average sized cupolas. With large heats and specially constructed cupolas duties of 1 : 11 to 1 : 14 have been reported in the American Machinist. As I said in my letter of last week, Wheatley has reported 1 : 17, and intimates that that represents practice in the north of England I for one should be pleased to know whether any one in this country has been getting a duty of 1 : 22 or so out of the Bollinckx or Greiner Erpf cupola. Joseph Torrey.

Cambridge, Mass.

Mr. Maxim's Flying Machine.

Editor American Machinist:

In writing the letter published in the American Machinist September 6th, on the Maxim Flying Machine, I did not have a thought of personal spite or malice toward Mr. Maxim. I believe an engineer has the right to give public expression to his views on aerial navigation or any other subject if he chooses. If Mr. Maxim felt called upon to make reply to my letter, I think the readers of the American Machinist had a right to expect something of a technical character worthy of a man of his reputation. The publication of Mr. Maxim's letter of October 11th entitles me to a few words in reply. In my communication of September 6th, I endeavored to show that while Mr. Maxim had done very creditable work in producing a boiler and engines of very light construction, the whole machine was of such a large size that as a practical flying machine it was not a success. I believe all of the facts bear me out in this conclusion.

Mr. Maxim seeks to throw discredit upon my statements by saying that I was not present at certain experiments, that I never ran the engines, and that I never saw the new machine he conducted his last experiments with. I was actively employed at Mr. Maxim's during a period of about eight months. In this time many experiments were performed which I naturally took an active part in, and did repeatedly run the engines in the presence of many witnesses; Mr. Maxim's statement to the contrary notwithstanding. The "new" machine, as Mr. Maxim styles it, is the same machine that previous experiments were performed with, the only difference being that the large aeroplane and the fore and aft rudders have been reconstructed. This was made necessary by a breakage that occurred in the early part of March last. On the occasion of an attempt to run the machine, Mr. Maxim ordered the forward rudder to be placed at a considerable angle for the purpose of increasing the lift. On this occasion Mr. Maxim looked after the fire under the boiler, while I had charge of the engines. This was the usual arrangement on all of our trips. On this particular trip we had moved but a short distance forward when the forward rudder was seen to lift out of position, and I shut off steam, but before the machine could be stopped the rudder had collapsed, its steel frame being broken and twisted into a shapeless tangle; and falling backward upon the large aeroplane badly broke and damaged that. As I had previously been convinced that no

really practical results could be obtained with this machine, I advised the abandonment of experiments with it, but Mr. Maxim decided to reconstruct the aeroplane and rudders. I at once proceeded with the work, and made drawings of a somewhat smaller aeroplane, and rudders that are stiffer and of better figure than the old ones.

It may be of interest to note here that a suggestion from me to construct strain diagrams for this work met with ridicule from Mr. Maxim, which did not deter me from making them for the principal members of the new structure. As each part was made it was tested with a proof strain in excess of that required upon it in the machine. Such investigations give a basis for intelligent statement. I remained until nearly all of the new parts were made, and the frame for large aeroplane was in position on the machine, when I resigned my position, after giving Mr. Maxim customary notice. *I was not discharged.* On the contrary, Mr. Maxim took occasion to congratulate me on the satisfactory manner in which I had conducted the work.

In my former letter I had no intention of drawing unfavorable comparisons between Mr. Maxim and Professor Langley. Mr. Maxim does not correctly quote what I said. I did not make the statement that Professor Langley had lifted 250 pounds per horse-power, and that Mr. Maxim had, with a similar apparatus, lifted only 133 pounds, as reference to my letter will show. What I did endeavor to show was the great disparity between the theoretical results as obtained by Professor Langley and those obtained from Mr. Maxim's machine. Mr. Maxim knows very well that I would not assert that a machine could be made carrying its own motor that would be as efficient as the experimental apparatus of Langley's. I stated the lift of Mr. Maxim's machine to be 25 pounds per horse-power, while he states in his letter that he has lifted something over 27 pounds. This is a little better, but as he bases his figures on an assumed total lift of 10 000 pounds, and as this is much in excess of the weight of the machine, it would be interesting if he would state how he obtained the record. What I have always maintained is that the larger the aeroplanes the less will be the efficiency, owing to imperfect figure and the air resistance caused by the increased number of supports and stays needed to sustain such structures. Enlargement of the aeroplanes also means additional weight per unit of surface. Mr. Maxim offers nothing to contradict this.

Mr. Maxim claims that I copied verbatim from certain instructions given by him, and that I also made use of an article that was published in the *Fortnightly Review*, of October, 1892. This statement is untrue. From very crude and imperfect data supplied by Mr. Maxim, I worked up a design for an aerial machine in which Mr. Maxim wished to embody results obtained by Philips with narrow superposed planes which he proposed to combine with a large aeroplane Mr Maxim applied for a patent on this design. I have not a copy of the *Review* article referred to, and do not know what it contains I did say that it was possible that a comparatively small aerial torpedo could be made that would fly, but my conception of such a machine would be quite unlike anything Mr. Maxim ever advocated. I do not know that any one man has a monopoly of ideas and opinions.

I have taken occasion to point out that in a machine as large as Mr. Maxim's, the efficiency of the aeroplanes will be reduced by imperfect figure, increased weight per unit of surface, and by the resistance of a large number of supports and stays, while the structure will be so weak that it will be unsuited for the purpose of a practical flying machine. I believe Mr. Maxim's machine exceeds the practical limit in size, and certainly the successful machine has not been built. ARTHUR L. STEVENS.

[The statement in Mr. Maxim's letter as to the manner of Mr. Stevens leaving his employ, was published only by reason of an oversight on our part. It was sufficient for the purposes of the discussion to have said simply that his connection with the work ceased at a certain date. Having inadvertently allowed Mr. Maxim to say "discharged," we feel bound to allow Mr. Stevens to deny this, and say he resigned, but the manner of his leaving has really nothing to do with the merits or demerits of Mr. Maxim's machine, and we shall hope and expect that discussion will hereafter be confined strictly to mechanical and scientific points.—ED]

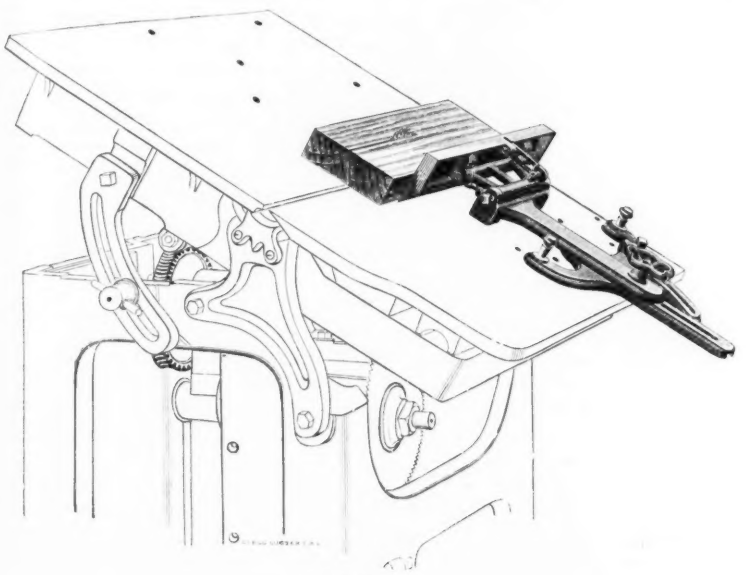


Fig. 3.

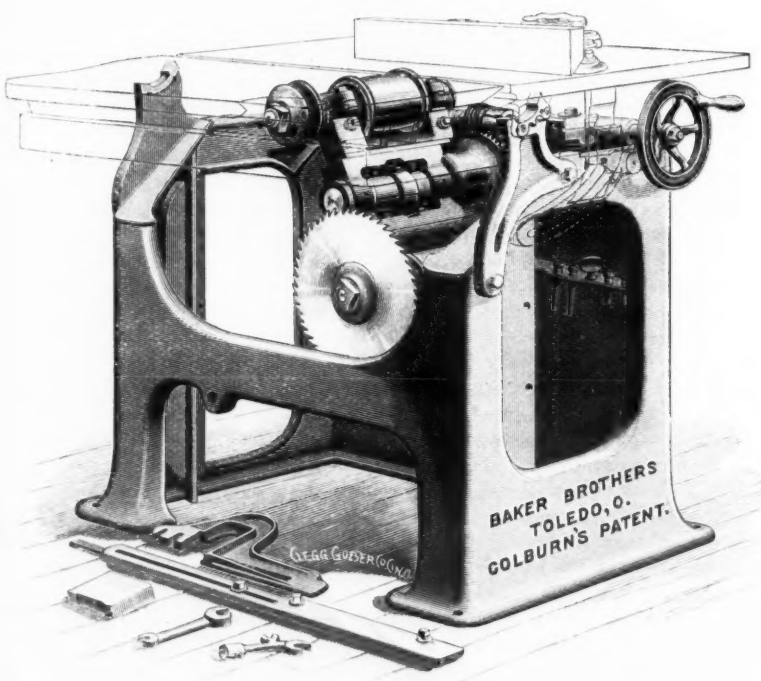


Fig. 2.

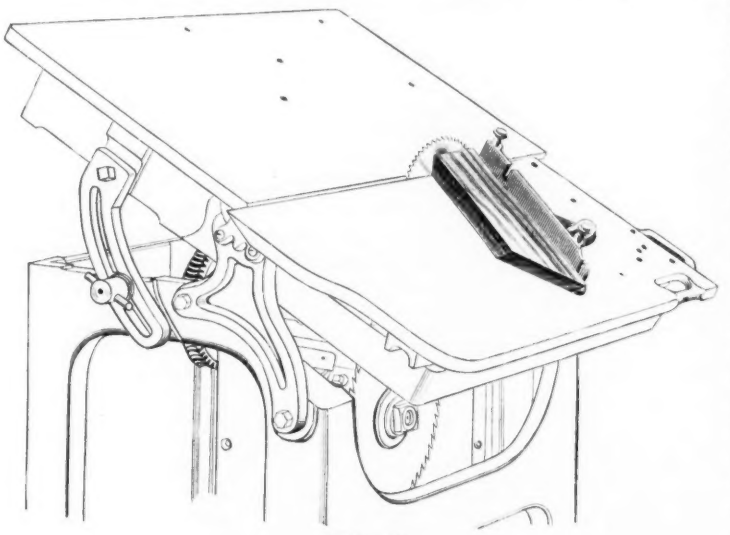


Fig. 4.

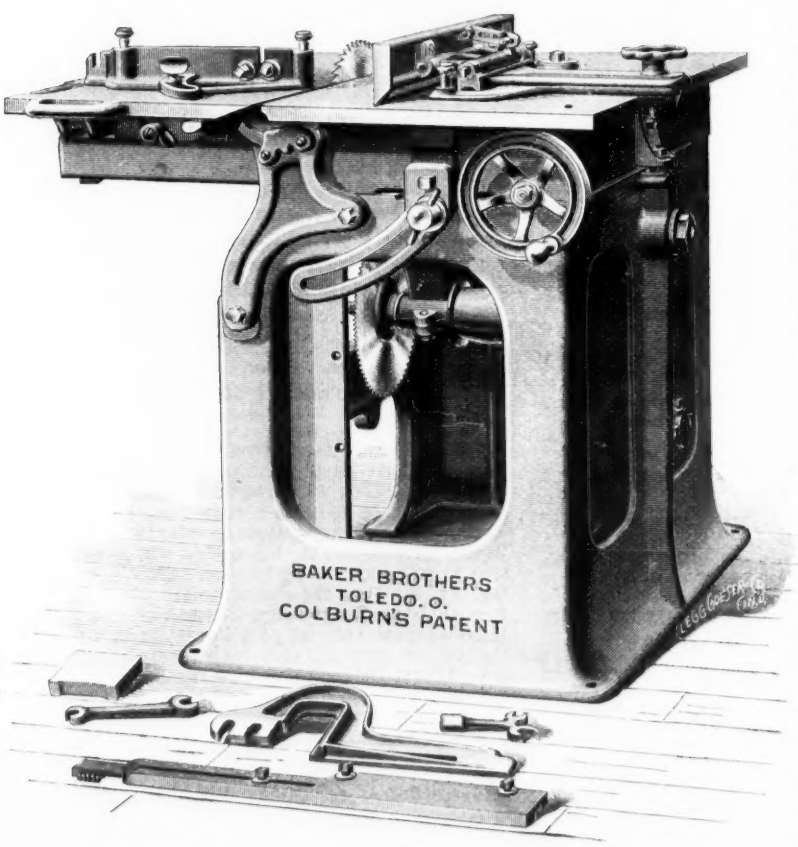


Fig. 1.

THE COLBURN UNIVERSAL SAW BENCH.

The Colburn Universal Saw Bench.

We illustrate herewith an improved universal saw bench, built by Baker Brothers, of Toledo, Ohio. This machine consists of a main frame, or housing, cast in one piece. To one side is fitted a stud, extending inwardly, having one end tapered and held rigidly in its bearing by means of a nut, as shown at the right in Fig. 1. This carries a revolving or swinging frame in which are journaled two steel arbors, running in self-oiling boxes, which are adjustable for taking up all wear, and so arranged as to set the saws any height relative to the top of the table for gaining, rabbeting, grooving, tonguing, etc. This movement of the saws is accomplished by means of the hand wheel shown at the right of the frame, which actuates a worm and a gear.

On the left hand is a sliding iron table, resting on long tracks and moving easily on rollers. This whole table is adjustable toward and from the saws for wide grooving, dadoing, etc., for which special heads are used. It also carries a cutting-off gauge, as shown in Fig. 1, which is swung over a graduated arc, and is held to the table by means of two taper pins, and accurately drilled for an octagon, hexagon, mitre and square. For other angles the gauge is pivotally moved on the right-hand pin and fastened with a thumb screw as shown.

The table on the right carries a splitting gauge which has a movement over the entire width of this table and can be set to cut any desired angle. It can also be set diagonally with the saw for hollowing out core boxes which work is performed with great rapidity and perfect accuracy.

The whole main table is also adapted to swing on the frame, as shown in Figs. 3 and 4. This feature is of great value in sawing out staves for cylinder, column and other similar patterns, and on such work as newel posts, cisterns, etc., and for sawing double or flaring angles.

The splitting gauge is adapted to be used on the sliding table, as shown in Fig. 3, and when used in this manner is very convenient for ripping bevels in heavy stock, the table being tilted at any desired angle up to 45 degrees. An advantage gained in working in this manner is that the stock, by reason of its own weight, will tend to keep against the gauge. When the splitting gauge is used in this manner the sliding table is firmly locked by means of a catch underneath to keep it from sliding.

As will be readily perceived, this machine, by the facility of adjustment provided for saws, table and fixtures, enables almost anything capable of being done by saws, gaining heads, etc., to be readily done upon it, and for the large variety of operations incident to the pattern-maker's work it should prove very useful.

It is reported that the Navy Department is about to purchase 700 rapid fire guns, which are to be used for the "auxiliary navy," *i. e.*, the merchant vessels, which can at any time be called into the service, and are to be fitted for the reception at short notice of the guns and other paraphernalia. Among these vessels are the "Paris" and "New York," and the new additions to the American Line fleet now being built at Cramp's.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

Horace B. Miller, Pres't and Bus. Manager.
Lycurgus B. Moore, Treas. and Sec'y.

Fred J. Miller, J. G. A. Meyer, } Editors and Mechanical Engineers.

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"Business Specials," 50c. a line.
No Commission allowed to Advertising Agents.

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Subscriptions received in Paris, France, by E. Terquem, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. Williams, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, OCTOBER 25, 1894.

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Long vs. Short Connections to Indicators.

The discussion started in our columns by Mr. Willis' statement of results obtained by a test of indicators connected to the same engine, one by short and direct, the other by long and circuitous connections, still echoes and re echoes in the columns of our contemporaries, and much that is written regarding the matter seems to be based upon the assumption that Mr. Willis had, with malice aforethought, attacked one of the dearest and most revered traditions of steam engineering and had proclaimed the victory over it, the facts being, however, as most of our readers know, that Mr. Willis did nothing in the world except to show that under certain conditions (which were carefully and fully stated by him) the difference in results as between the two methods of connecting was inappreciable.

He did not claim a fraction of an inch or a pound outside, or different from what his carefully conducted experiments proved, and never pretended or thought of pretending that, on account of these experiments, an engineer could safely disregard the well-established practice of making connections as short and direct as possible, unless perchance all conditions should happen to be precisely the same as they were when he made his experiments.

Other experiments to show that under different conditions it does make a difference may be, of course, interesting and instructive, if as well and carefully made, but no number of such experiments can possibly discredit Mr. Willis' experiments in the least or prove (what most engineers have hitherto believed) that in *no* case and under *no* circumstances can long and circuitous connections give the same results as short and direct ones.

As before mentioned, the able editor of our contemporary, *Power*, assumed that Mr. Willis' pipes added 10 per cent. to the clearance of the cylinder and thus seriously affected the results; but when it was pointed out that the added clearance was really only one-tenth of 1 per cent. instead of 10 per cent. he made experiments of his own and published drawings illustrating them, claiming that in this case added clearance had manifestly affected the results. But now comes Mr. Harris Tabor, an undoubted authority on such matters, and says of these experiments:

Mr. Low's results as given in the September issue, are cited to show that this increased clearance will produce the result he claimed, viz., a reduced pressure in the indicator. An examination of his indirect piping as pictured in his article will show that he suffered, not by increased clearance, but by dividing the steam which should flow through one passage to the indicator, into two passages, one of which went to fill the indirect pipe. If his indirect pipe had led off from a separate opening in the engine cylinder it is probable that his test would have shown no appreciable effect of the increased clearance.

At the same time Mr. Tabor shows that, under different conditions, different results would have been obtained by Mr. Willis, which is undoubtedly true, and has, so far as we know, never been disputed by any one. All that Mr. Willis or this journal ever claimed for the experiments was that the results were interesting, were not what most engineers would have expected, and that they added something of value to the literature of the subject; and these claims seem to be well borne out.

World's Fair Medals.

Not the least wonderful thing connected with the Columbian Exposition was the number and portent of unforeseen difficulties which arose, and the manner in which for the most part they were successfully overcome, and the Exhibition made triumphant seemingly in spite of fate. Even now that the Exhibition has been closed for a year misfortune seems to pursue it, the latest manifestation of this being in connection with the manufacture of the medals which were awarded to exhibitors. As practically everybody who made an exhibit was awarded a medal, there are many thousands of them to make, so that following the delay resulting from the failure of groveling congressmen and others to appreciate St. Gaudens' high art design, comes now a further consumption of time on account of the number of dies that must be made, and the great length of time required for the coining operations to be completed.

Upon a shield, which forms part of the design, the name of the individual or firm to whom the medal is awarded is to appear, and a separate die must be made and inserted for this part of the design for every medal struck. To make matters worse, it is now discovered that some of the foreign firm names are too long to be put into the space allowed for them, and correspondence must be entered into regarding possible abbreviation of some of them, and the present outlook seems to be that no medals can be actually issued before next spring some time; many of the exhibitors in the meantime clamoring for them as vociferously as if they thought they would be of some actual value when obtained, which they may be in some cases, possibly.

The Armor Plate Frauds.

On another page of this issue we publish an article on the armor plate frauds, written by an engineer who has made a specialty of tests of materials, and who writes from an intimate personal knowledge, not only of the general processes of testing and of testing machines generally, but also of the particular establishments in which the work has been going on, and the particular methods and machines in use there.

In the nature of things, much that is known by such a man cannot with propriety be published; but, nevertheless, what is given will be found of interest and value to those who wish to be informed upon the subject. Much that is connected with this matter of inspection of materials is typified by the words of a very prominent and very wealthy manufacturer of armor plates and other material for the government, who said that it was much cheaper for him to provide luxuriously fitted up and luxuriously supplied club rooms for government inspectors than to have them going about the works all the time—words which might, it is true, have a perfectly innocent meaning, and, again, might not, with the probabilities largely in favor of the latter.

What seems likely to prove a very important order has been issued by Secretary of the Navy Herbert, by which the responsibility for the proper construction of naval vessels will be concentrated upon one man, and he at the head of the Bureau of Construction and Repairs. At present, this man is Chief Constructor Hichborn, and from this time on, so long as the new order stands, he or his successor will be responsible for the proper balancing and adaptation of the work of the various bureaus which co operate, or at least should co-operate, in producing a complete naval vessel. Mr. Hichborn is, by the new order, apparently given authority proportioned to his responsibility, and it would seem as though we ought hereafter to hear less of miscalculations respecting metacentric heights, stanchions obstructing the movement of guns, and evident efforts of different bureaus to shift responsibility, and put other bureaus "in a hole." The new rule seems to be in accordance with common sense, and will bring the work of construction more nearly in line with what experience has shown is the only proper way of managing industrial operations.

A good example of what may be done by a skilled engineer, working in the light of modern practice, is shown by the results obtained by Horace See, of this city, in rejuvenating the steamer "Louisiana," of the Cromwell line. The vessel was built at Roach's 15 years ago, and was a good vessel of that time. Now, however, her old boilers have been replaced by double ended Scotch boilers, made of open hearth steel, 12 feet 9 inches diameter of shell and 20 feet long, and the working steam pressure is 170 pounds per square inch. The new funnel is higher and of less diameter than the old one. The new engines are of modern construction also, and the changes have resulted in lessening the vessel's draught 14 inches, her coal consumption about 25 per cent., increasing her speed three knots per hour, and her carrying capacity by 500 to 600 bales of cotton; results which may easily, and probably do, make the difference between a vessel that did not pay and one that does pay.

On a succeeding page of this issue we give an account of one of the most remarkable and destructive boiler explosions that ever occurred in this country, written by an engineer whose specialty is boilers, and who probably gives the true cause of the disaster. It is, after all, the old story which has been written over and over again, often in the blood of innocent victims, and it will continue to be written probably until there is as strict government supervision of boilers used on land as at sea.

Literary Notes.

AIDS TO ENGINEERS' EXAMINATIONS. Prepared for applicants of all grades, with questions and answers. A summary of the principles and practice of steam engineering. By N. Hawkins, M. E., author of "Hand-book of Calculations for Engineers," "Maxims and Instructions for the Boiler Room," "Steam Engineering Miscellany," etc.

The object of this work is to aid applicants for an engineers' license to pass a successful examination. The book contains nearly 500 questions, any number of which may be asked by the examiner. An answer is given to each question. The questions relate to subjects with which competent engineers should be thoroughly familiar, and indicate the comparatively wide range of knowledge which an engineer must possess. The answers, although very useful in their way, should not be accepted by those who desire to occupy prominent positions, as a full acquirement of knowledge of the subjects to which they refer, but should form an incentive to inquire deeper into the matter, so as to become thoroughly familiar with the underlying principles.

The book also contains the laws of the United States, and of various States and cities relating to engineers' license, kindly advice, and general information useful to the engineer.

There is much in this work which can be commended, but it also contains answers obscure in meaning, and a few are erroneous and misleading. For instance, on page 25, we find: "Ques. What is the unit or measure of time? Ans. A minute." This is correct as far as it goes, but in engineering practice we also use the "second," and the "hour" for the measure of time. "Ques. What is the unit of pressure? Ans. The pressure of the atmosphere at the level of the sea, $14\frac{7}{10}$ pounds to the square inch." For the unit of pressure the pound is often taken, but we may also use the ton or the ounce, if we choose to do so for the unit of pressure per unit area. In this answer the author has overlooked the fact that he is using the pound as the unit of pressure. On page 32 we find the following: "Ques. What is an alloy; define it? Ans. An alloy is a mixture or compound of two substances. Example: Two parts of tin and six parts of lead is 'an alloy' suitable for fusible plugs, and which melts at 380° Fahrenheit. To alloy is usually to reduce the quality of one of the parts, and the least valuable is sometimes called 'an alloy.'" This answer is misleading; an alloy is a compound or mixture of two or *more* metals. It is of the utmost importance that the definitions, in works of this kind, should be correctly stated, otherwise confusion is sure to follow. Other answers which need revision can be quoted.

The typography is of a high order, and the binding is a fine specimen of the book-

binder's art. The work is published by Theo. Audel & Co., 21 Liberty street, New York. Price of the book, bound in red leather, gilt edges, $2.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(489) O. E. E., York, Neb., writes: Please inform me how locomotives are classified by letters, as class H, class M, etc.? *A.*—There is no rule by which locomotives are classified by letters, the whole system of classification is arbitrary; builders or railroad companies use such letters for designating the class and size of engine as best suits their own views.

(490) J. R. C., Chicago, Ill: Since answering your question in reference to the Mekarski system of train traction by compressed air, we have been informed that three cars of this system are running in Westfield, Mass. It is said that these cars are running very successfully. You may obtain the information you seek by writing to the Rand Drill Company, 23 Park Place, New York.

(491) C. A., Macville, Canada, writes: I have a recipe for a varnish which is composed of linseed oil, oil of turpentine, and amber fusel. It says "Dissolved by heat." I have heated it in an open can until the liquid is half gone, and the amber does not seem to dissolve much. What shall I do with it? *A.*—Throw it away. Then take fragments of amber and heat them cautiously in an iron pot; as soon as it becomes semi-liquid, add gradually an equal weight of pale boiled linseed oil which has been previously heated, and stir well until the whole becomes thoroughly blended. Then thin down with oil of turpentine. In order to keep this varnish for any length of time, air must be excluded. Your second question is out of our line.

(492) E B., Montreal, Canada, writes: I am building a vertical compound engine; high pressure cylinder, 3½ inches diameter; low pressure cylinder, 7 inches diameter; both 6 inches stroke. The high-pressure cylinder is to be above the low-pressure cylinder. Please give the size of ports, lap of valve, diameters of crank shaft and piston rods. *A.*—Size of steam ports in high-pressure cylinder, 2 inches by $\frac{3}{8}$ inch; steam ports in low-pressure cylinder, 6 inches by $\frac{3}{8}$ inch. The width of exhaust ports should be about twice the width of their respective steam ports. Lap of high-pressure valve, $\frac{9}{16}$ inch; lap of low-pressure valve, $\frac{9}{16}$ inch. Diameter of crank shaft, 1$\frac{3}{8}$ inches; diameter of piston rod, 1 inch. 2. Can I run both valves with one eccentric? *A.*—Yes, but two will be better.

(493) W. J. C., New Orleans, La., writes: a wish to obtain a treatise (if such exists) or In article treating on the comparison of pneumatic and steam machinery as regards their structural details, giving the changes necessary to convert either class of machine into the other class. For example: Suppose we wish to drive an ordinary pneumatic boiler riveter by steam, what structural changes, if any, would have to be made in it? *A.*—Many of these riveting machines can be operated by air or steam pressure without making any change in their construction. The change necessary for converting other classes of pneumatic machinery to steam machinery will depend on the design of the machines, and these changes will readily suggest themselves to any one who is familiar with pneumatic and steam engineering. We do not know of any book which treats on the subject to which you refer, and believe there is none published.

(494) F. M. G., Seneca Falls, N. Y., asks: What is the ratio of the tensile breaking load of a threaded rod and a rod of the same material, having a diameter equal to the diameter of the threaded rod at the base of the threads? *A.*—The tensile strength varies with the cross sectional areas of the rods. In computing the strength of the threaded rod we take the area in square inches of the circle at the base of the thread, and multiply it by the tensile strength per square inch, the result will be the load. For computing the strength of a solid rod we employ the same rule, taking, of course, the cross sectional area of the rod. According to your question, the area of the solid rod and the area of the threaded rod at the base of the thread are equal, hence both rods will require the same breaking load, consequently the ratio is 1. 2. Where can I find tables of the breaking load of threaded rods? *A.*—We have not seen tables of this kind, and in fact, none are required, as will be evident by the above remarks.

(495) S. S., Toronto, Canada, writes: I have a lot of small malleable iron castings that I would like to tin, but I do not know how to get them bright and clean. What do you consider the best method to get them clean and smooth so as to tin nicely? *A.*—Castings are generally cleaned for tinning by immersion in dilute sulphuric acid and water (1 to 20 of water) and then scoured with sand, followed by washing in water. 2. Do you use the pure block tin only, and is it necessary to use a flux; if so, what does it consist of, and how can I use it? *A.*—Small castings, after they have been cleaned, can be tinned by boiling them with scraps of block tin in a solution of cream of tartar. 3. What is the best solution for drilling wrought iron? I would prefer not to use oil. *A.*—We do not know the best solution for this purpose, but one which we believe is very good is to take 10 pounds whale oil soap, 15 pounds sal soda, 2 gallons lard oil. Shave the soap so it will dissolve readily and put the whole into a clean 40-gallon cask and fill with water. Put in a steam pipe and boil it until thoroughly dissolved, when it is ready for use.

(496) C. F. E., Chicago, Ill., writes: Please give me the rule for finding the horse-power of compound and triple expansion condensing and non-condensing engines. Also what will be the difference between condensing and non condensing? *A.*—In computing the horse-power of any multiple stage engine, compound, triple expansion, etc., it is customary to assume that the work of all the cylinders is done in the low pressure cylinder, or, in other words, that the total expansion occurs in the cylinder or cylinders that exhaust into the condenser; and it is also assumed the expansion curve is a rectangular hyperbola. The first step in computing the horse power of any of these engines is to find the equivalent mean effective pressure that would be required if the work of all the cylinders were done in the low-pressure cylinder. The manner of finding this pressure is explained in answer to Question 466 in our issue of October 4th, current volume. After this pressure has been determined use the same rule for computing the horse-power as is used for computing the horse power of simple engines, namely,

$$H = \frac{A \times P \times S}{33\,000},$$

in which H = indicated horse power, A = area of piston in square inches, and S = speed of piston in feet per minute. The same rule is used for condensing and non-condensing engines, the only difference between the two is the value of P, that is, the equivalent mean effective pressure, which depends on the initial pressure and the ratio of expansion.

(497) C. L S., Monterey, Mexico, writes: The inclosed sketch shows an end view of a Corliss engine and a partial sectional view of a heater, and the exhaust pipe from engine to heater. It is claimed that the heater shakes when the engine is running. D. claims that the two elbows in the exhaust pipe from engine to heater cause back pressure, and this is the cause of the heater shaking. The exhaust pipe is 4½ inches diameter, and the exhaust pipe from the heater to the air is of the same diameter. I claim that the heater was properly set and connected, and if the heater shakes, as is claimed, it is due to some other cause. *A.*—The vibration of the heater may be due to several causes, but we are inclined to believe that it is not due to the elbows. It may be due to the exhaust from the engine rushing against the coils in the heater, or it may be due to the pump which forces the water through the coils. It is also possible that the engine is not correctly balanced, causing a vibration in the foundation and transmitting it to the heater, which seems to be set very close to the engine. The diameter of the heater, according to your sketch, seems to be small, and its height comparatively great, which is liable to aggravate the trouble. In all probability the vibration will disappear by securing the heater more firmly to the foundation. 2. Is it practical to attach the steam gauge to the steam pipe when it cannot be attached to the boiler so as to be readily seen? In our case the steam gauge was put on the steam pipe in the engine room. D. says that this is not safe; I claim that it is practical and just as safe. *A.*—You are decidedly wrong. It is not safe to have the steam gauge attached to the steam pipes without having another one on the boiler. The steam gauge pipes should be attached to the top of dome or drum, and the steam gauge placed in some convenient position so that it can be consulted every few minutes. The sooner you have this done the better.

(498) C. E. K., Cortland, N. Y., writes: Kindly answer the following: Where can I obtain "Nystrom's Mechanics"? *A.*—It is published by J. B Lippincott, Philadelphia, Pa. You can also obtain it from any dealer in scientific works. 2. What is the best preparation in the grease line to apply on finished machine parts for the prevention of rust? *A.*—Vaseline is considered to be an excellent preservative; it can be bought in cans; it is applied with a brush. Boiled linseed oil is also good. For ordinary purposes, a mixture of tallow or lard and thick white lead paint rubbed on the polished surfaces is often used. 3. What metal or combination of metal is the most expansive for pouring into a solid bearing? The metal must not shrink and become loose in the casting. *A.*—Babbitt metal is generally used for this purpose. We know of no metal that will answer exactly the condition you give. 4. What method is most practical in making cone pulleys of four steps, the largest step being 14 inches, and the smallest one 6 inches diameter? The pulley must have no blow holes. Kindly explain the cause of the blow holes. Are they caused by using old, dirty scrap iron, and should they be made from good pig iron; or, are they caused by the mold not being properly vented? Should they be molded in green or dry sand? *A.*—The blow holes are caused by imprisoned gases, which having no means of escaping before the metal congeals, arrange themselves in various sizes and shapes under a thin film of metal. Another fruitful cause are the rusty chaplets and studs, which give off gaseous compounds as the rust decomposes. Blisters or blow holes are almost certain to ensue when a green sand surface, core, or cope is too damp or wet in spots. Should there be no vent at that particular part to lead away the steam as fast as it generates, it must inevitably find its way into the mold, the result being blisters. Sometimes blisters are caused by the sulphurous gas contained in the iron itself, which, if it once enters the mold, acts exactly like the gases mentioned above. Such gas as may be mingled with the iron will naturally ascend to the top if the mold's formation is favorable to its rapid transit in that direction; but should it be otherwise, the probabilities are that it will be found imprisoned at whatever part of the mold it happened to be when the latter had received its fill of metal. Better castings can be expected from clean than from dirty iron. The dry sand molds will probably give the best results. For finding readily information relating to molding, the "Dictionary of Foundry Terms," by S. Bolland, will be extremely useful to you.

(499) E. P. P., Dickey, Ga., writes: Some time ago I asked you to give me the dimensions of a vertical boiler 60 inches diameter and 11 feet high to carry a working pressure of 150 pounds. In your answer you gave a sketch of the boiler. Since then I have bought one, allowing the builders to give the proper dimensions. I inclose a blue print of the boiler. It has been in use about one month, and as I am not receiving the results I expected, I wish to get your opinion as to the cause of the trouble. One of the great troubles of the boiler is as follows: I can fire up in the morning with one gauge of water, and by the time I get a pressure of 60 pounds the water has risen up to 9 inches, or 1 inch above the top gauge. I use an 8 inch chime whistle, and when I blow at, say, 100 to 120 pounds pressure, it is open only a few seconds before water comes out, and I have to stop blowing it. *A.*—The dimensions of the boiler are practically the same as given in the answer referred to, with the exception of the tubes; these are, in your boiler, 2 inches diameter, and 172 in number. In our opinion a less number of tubes, and, say, 3 inches diameter would have given better results. Too many tubes in a vertical boiler will tend to retard the circulation immediately over the crown sheet, and may induce priming, which is always a troublesome and dangerous occurrence. The rapid rise of water in the boiler when firing up in the mornings may be due to foaming caused by the presence of oil, dirt, or other foreign matter in the boiler, indeed, to find such in a new boiler should not be surprising; this foaming may have deceived you in regard to the amount of water in the boiler. Again, it is not impossible that you were feeding water into the boiler without knowing it. The escape of water through the whistle is due to priming induced by a reduction of pressure in the boiler when the whistle is suddenly opened; you have probably placed the whistle too close to the water level, or it may be due to the presence of too much water in the boiler. 2. At present the boiler has to do light work; it furnishes steam for a double 8 horse power engine. I have great trouble in getting the boiler to hold water. For instance, I shut off the engine at 5 30 P. M., and feed water into the boiler with a No. 10 Hancock locomotive inspirator. I let the inspirator work 12 minutes after the water has reached the top gauge cock, under a pressure of, say, 80 pounds; in the morning I try the gauge cocks, and find the water below the lowest one. Of course, I have to pour in water until I get it up to the first gauge before I can fire. This gives me considerable trouble and loss of time every morning. Before I bought this one I used a boiler 44 inches diameter, 9 feet high, with 75 tubes 2 inches diameter, and it was much more economical than the large one, and did the same amount of work. I could feed water into the small boiler to the top gauge, and have one gauge in the morning. Now, I wish to know the cause of the large boiler losing so much water. *A.*—We are of the opinion that the loss of water is due to a leak in the boiler, or in some of its connections. It is also possible that in feeding the boiler in the evenings, foaming was going on, and that there was not as much water in the boiler as was expected.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

New Gear Book free. Grant; see page 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

Fine pat. work. H. Cooper, 118 William St., N.Y.C.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Match machines for sale, splint cutters, coilers & unloaders. I. L. Hawkins, bld'r, Waterbury, Conn.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

Model Locomotives. Complete sets castings N. Y. Central Standard up to date. Rough or finished. G. H. Olney, 163 Herkimer St., B'klyn., N. Y.

Emery, emery wheels, grinding machines and grinders' supplies, quick process and large stock. When in a hurry, buy of The Tanite Co., New York City, Cincinnati, Ohio, and Stroudsburg, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Multiple-spindle automatic screw machines, having 4 spindles, carrying 4 rods, 4 tools working together, making 4 screws at each rev.; perfect work and big product. E. B. Welch, 68 Dev. St., Boston.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

The Great Boiler Explosion—"Penny Wise Pound Foolish."

BY W. BARNET LE VAN.

On the morning of October 11th, at about 7.30 A. M., 27 boilers of a nest of 36 boilers at the Henry Clay colliery exploded, completely destroying the boiler house, killing four men, seriously injuring two, and slightly injuring four others.

At the time of the accident there were, as far as known, seven men immediately around the boiler house. Nobody seems to be able to give a correct statement as to the cause of the explosion. J. J. Dediam, the only remaining man who was in the building and able to talk, said that about ten minutes before the catastrophe occurred he made an examination of the boilers and found them full of water and apparently in

a perfectly sound condition. This first statement is confirmed by the condition of ruptured parts of the boiler after the explosion and the wet condition of the ground, etc.

The boiler house contained 36 plain cylinder boilers 36 inches in diameter, and 42 feet long, set in brick work in nests of three over one fire grate, and they were suspended from two girders, spanning each nest of three boilers, by two suspension bolts, each connected to each boiler. To every nest of boilers was an iron chimney.

The fire and flame came in contact with the lower half of the boilers, at their rear end before entering the chimney; a baffle wall brought the hot gases up to and around the lower half of the boilers, as shown by the sketch.

Each boiler was composed of 13 rims $\frac{5}{16}$ inch thick. The statement is that without a moment's warning the last boiler on the west side of the nest exploded, and it was followed by the others in rapid succession. The men employed in the boiler room were knocked in every direction, and what had been but a few minutes before a strong corrugated iron building, disappeared as if by magic, and all that remained was a confused mass of bricks, girders and timbers, besides numerous pieces of twisted pipe and battered boiler iron shells.

The nine remaining boilers were so injured and the defects of the boiler plate exposed that they will never be used again. Pieces of heavy iron were carried at least a thousand feet, while a half of a boiler was found over a quarter of a mile away up the mountain. The report was heard for miles.

Three of the men were dead when taken out, and the remains of some, as well as being crushed, were frightfully burned by coming in contact with the heated iron and coals from the fire boxes. One of the men was completely cut in two, besides having both arms severed from his body.

There was one man whose escape with injuries comparatively light was marvelous. He was standing but a short distance from the boiler house when the first explosion occurred; but before he could move a step the others followed, and he was knocked senseless by a flying brick. One man was in the act of cleaning a safety lamp in a building used for that purpose; the house was badly wrecked and he was struck by a piece of the boiler cutting his flesh in numerous places. Several men and boys had close calls and were more or less injured. A section of boiler, about six feet in length, lodged in the side of the breaker, within a few feet of where a number of boys were working. Quite a number of men and boys saw the pieces of iron coming and ran for their lives.

The monetary loss attending the accident will probably reach $25,000 or $30 000

THE CAUSE OF THE EXPLOSION.

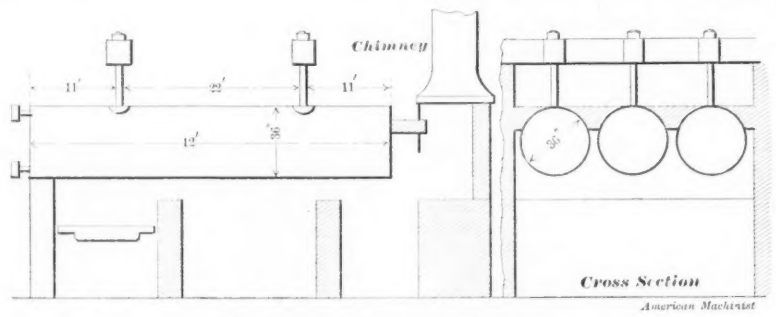
The cause was not due to the want of water in the boilers, as an examination of the ruptured parts gives evidence to the contrary, and the ground upon which the catastrophe took place was covered with water from the boilers.

The theory advanced by those connected with the works, namely, that a quantity of gas in the coal used for fuel exploded and disarranged the boiler at the western end and caused it to explode, thus weakening the others, is not tenable in view of an examination of the shell plates of the exploded boilers, which show, conclusively, that they were made of inferior material. The broken parts of $\frac{5}{16}$ inch thickness show two covers (inside and outside of the plates of fair material, $\frac{1}{32}$ of an inch in thickness, and the center filled in with inferior material; "shoddy," it may be termed.

How these boilers resisted the steam pressure of 90 pounds per square inch above the atmosphere for the last three years (I understand this is their age) passes my comprehension. And another singular circumstance is that the single riveted horizontal seams, the weakest part of the boilers, did not give way, but the transverse joints in every case did, although considered the strongest of the two.

From the manner in which these boilers were set, that is to say, the setting being such that the lower half of the boilers was in direct contact with the flame, while the larger portion of the upper half was exposed to the atmosphere, it is evident that unequal contraction and expansion of the boilers was the consequence; and, further, an unequal strain was imposed on the transverse joints. This being the case, and the material of the boiler being, as stated, defective, the west boiler of the number separated transversely, and caused the others to explode by concussion transmitted through the main steam pipe, of eight inches diameter, which connected with all.

Had these boilers been constructed of first-class material, the cost of which would not have exceeded one half cent per pound over what they did cost, or $30 per boiler additional, a total of, say, about $1,100, they would in all probability be in good service to day and the owners would have been saved an estimated loss of about $30,000, to say nothing of the loss of life and limb. Further comment is unnecessary.



SETTING OF EXPLODED BOILERS.

Milk Sterilizing Apparatus.

With this we give an illustration of an apparatus for sterilizing milk, recently brought out by Major E. Leslie, of Paterson, N. J. Its principal parts are: The cylindrical boiler A, whose diameter is increased over the furnace so as to provide for a sufficient amount of steam room, it is set in masonry as shown; a milk conduit B, a revolving cylinder C to which the stirring blades D are attached, and a covered cooling table E.

The milk circuit extends throughout the whole length of the boiler and passes through the head f into the cylindrical chamber g which receives the milk through the pipe i from a reservoir not shown in the illustration. The other end of the milk circuit is bolted to the head j; a discharge pipe k is attached to its upper portion, and another discharge pipe l is attached to its lower part. Both pipes discharge into the reservoir m which extends throughout the whole width of the cooling table and serves to give an even distribution over the cooling surface. Each pipe has a valve n for regulating the flow of milk. The revolving cylinder is made comparatively large in diameter for the purpose of presenting a thin body of milk to the heating surface. This cylinder is mounted on a longitudinal shaft which has a bearing in the head j and is supported at the opposite end by the stuffing box in the head of the cylindrical chamber g. This shaft, cylinder, and its stirring blades are made to revolve by means of the crank o. The discharge pipes k and l and the boiler head j are provided with thermometers for the purpose of ascertaining the temperature of the milk in the circuit and that of the water in the boiler.

The operation is simple; the water is raised to the required temperature, the flow of milk through the pipe i is then turned on and the circuit filled; when the milk has been raised to the required temperature the stirring apparatus is set into motion, the valve n in the discharge k is opened, and the milk is allowed to flow over the cooling surface into the receiving tank h.

It will be noticed that the milk enters the coolest part of the conduit and is discharged at its hottest part over the furnace; this will raise the temperature of the milk gradually, and since the conduit is surrounded by hot water the milk cannot be scorched in one part and remain comparatively cool at another part, and in flowing over the cooling surface the temperature is sufficiently reduced for bottling.

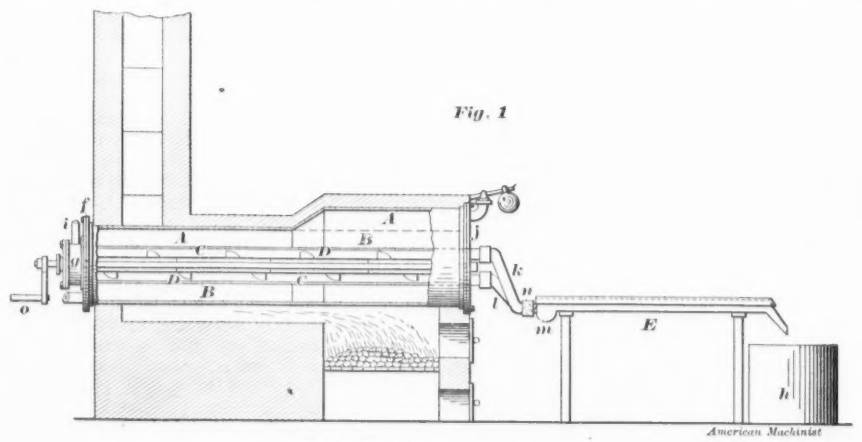
To empty the sterilizer of milk the valve in the discharge pipe l is opened. The boiler is emptied and filled through the pipe at the bottom of the head f.

The advantages of the invention are evident; the milk flows from reservoir to the receiving tank h continuously without being handled by the operators and without being exposed to the atmosphere. It is gradually raised to the temperature required, and its flow is regulated to a nicety.

Ample provisions are made for cleaning; the stirring apparatus can be taken out through the cylindrical chamber g, and when required the whole circuit can be taken out through the head f.

The apparatus has a large sterilizing capacity with a small fuel consumption. The advantage of sterilizing, or, in other words, subjecting the milk to a temperature approximating the boiling point of water, which is sufficient to kill all the germs of disease, need not be dwelt upon here.

Fig. 1



MILK STERILIZING APPARATUS.

Calculations for the Flow of Water in Pipes Simplified—II.

BY WILLIAM COX.

In dealing with practical problems relating to the flow of any fluid in a pipe, it is necessary to keep clearly in mind the relationship to each other of the different subdivisions of the total head or fall of water. This may, perhaps, be clearer if instead of speaking of *head*, we use the term *pressure* in pounds per square inch. Thus, suppose that water is being forced through a pipe with a certain pressure, P pounds per square inch, then a portion of this, or V_p pounds, is absorbed in giving to the water its velocity of flow, another portion, F_p pounds, is absorbed in overcoming the internal resistances caused by the friction of the water against the sides of the pipe, while a third portion may, or may not, be held in reserve to be available as effective pressure, E_p pounds, for producing power, as in the case of a turbine, or a fire stream drawn directly from a main.

If now, instead of these subdivisions of the total pressure, we designate them as similar subdivisions of the total head, we then have:

	Head.		Pressure.
Velocity	$= V_h$ feet, or	$=$	V_p pounds.
Friction	$= F_h$ " "	$=$	F_p "
Effective	$= E_h$ " "	$=$	E_p "
Their sum	$= H$ feet, "	$=$	P pounds,

which is the total head, or the total pressure.

As it is not generally practicable for water to flow through a pipe with a velocity greater than about 6 feet per second, the pressure to produce velocity will rarely be as much as one pound per square inch. Formula 2 includes this velocity head in the friction head, so that in ordinary cases F_h and F_p are practically equal to $F_h + V_h$ and $F_p + V_p$; and if the discharge takes place *freely into the air*, that is, if no effective head or pressure is reserved, then F_h and F_p become equal to H and P. It is in this sense that the term H is employed in Eq. (2); consequently the quantities with which we have to deal in practical work are generally H or P, F_h or F_p and E_h or E_p, where

$$H = F_h + E_h, \text{ and}$$
$$P = F_p + E_p.$$

Before proceeding to the consideration of compound and branch pipes, and pipes with distributed discharge, two or three other minor matters may be found of interest.

In the case of water-works mains, the required discharge is generally spoken of in gallons. When this is the case, Eq. (1) becomes

$$G = V \times d^2 \times 2.448, \qquad (3)$$

where G = discharge in gallons per minute.

Table III. gives this discharge for pipes from 1 to 48 inches diameter and for a uniform velocity unit of 1 foot per second; it is used in precisely the same manner as Table I., so that further explanation or illustration is not necessary.

When it is desired to find the head or pressure which produces any given velocity of discharge, the following should be used:

$$V_h = V^2 \times 0.0155, \qquad (4)$$
$$\text{or } V_p = V^2 \times 0.00673, \qquad (5)$$

TABLE III.

DISCHARGE FROM PIPES IN GALLONS PER MINUTE, WITH VELOCITY = 1 FOOT PER SECOND.

Diam. Ins.	Gallons.	Diam. Ins.	Gallons.	Diam. Ins.	Gallons.
1	2.448	17	707.47	33	2665.9
2	9.792	18	793.15	34	2829.9
3	22.032	19	883.73	35	2998.8
4	39.168	20	979.20	36	3172.6
5	61.200	21	1079.6	37	3351.3
6	88.128	22	1184.8	38	3534.9
7	119.95	23	1295.0	39	3723.4
8	156.67	24	1410.0	40	3916.8
9	198.29	25	1530.0	41	4115.1
10	244.80	26	1654.8	42	4318.3
11	296.21	27	1784.6	43	4526.3
12	352.51	28	1919.2	44	4739.3
13	413.71	29	2058.8	45	4957.2
14	479.81	30	2203.2	46	5180.0
15	550.80	31	2352.5	47	5407.6
16	626.69	32	2506.7	48	5640.2

The discharge for all other velocities is in strict proportion to the above.

where V_h is the head in feet, and V_p is the pressure in pounds per square inch which will impart to the water the velocity V.

It is often more convenient, as in the case of water works mains, where the pressure is required to be known for fire hydrants, etc., to base all calculations upon pressure in pounds instead of heads in feet. To reduce heads in feet to pounds per square inch, multiply the head by 0.4335; so likewise Eq (2 a) becomes

$$K = \frac{d \times F_p \times 2\,768}{L} \qquad (6\text{ a})$$

and 2,768 takes the place of the constant 1,200 in its different transpositions, which need not be repeated, but which will be

referred to as (6 b), (6 c), and (6 d). In the above Fp is the pressure in pounds necessary to overcome friction and produce velocity, which, added to the reserved effective pressure Ep, makes up the total force acting upon the water in the pipe. If the *whole* pressure is taken up in producing velocity and overcoming friction, then $Fp = P$, just as in Eq. (2) $Fh = H$ under similar circumstances. Table IV. gives,

TABLE IV.

OF VELOCITIES WITH CORRESPONDING HEADS AND PRESSURES.

Vel. Head. Inches.	Vel. Pressure Pounds per Square Inch.	Vel. Feet per Second.	Vel. Head. Feet.	Vel. Pressure. Pounds per Square Inch.	Vel. Feet per Second.
0.186	0.0067	1.00	1.255	0.5451	9.00
0.744	0.0269	2.00	1.550	0.6730	10.00
1.000	0.0361	2.32	2.000	0.8670	11.35
1.674	0.0606	3.00	2.307	1.0010	12.19
2.000	0.0722	3.27	3.000	1.3005	13.90
2.976	0.1077	4.01	4.000	1.7340	16.05
3.000	0.1084	4.01	4.614	2.0000	17.24
4.000	0.1445	4.63	5.000	2.1675	17.94
4.650	0.1682	5.00	6.000	2.6010	19.66
5.000	0.1806	5.18	6.920	3.0000	21.12
6.000	0.2167	5.67	7.000	3.0345	21.23
6.696	0.2423	6.00	8.000	3.4680	22.70
7.000	0.2529	6.13	9.000	3.9015	24.07
8.000	0.2890	6.55	9.227	4.0000	24.38
8.000	0.3251	6.95	10.000	4.3350	25.38
9.114	0.3298	7.00	11.534	5.0000	27.26
10.000	0.3612	7.32	13.841	6.0000	29.86
11.000	0.3974	7.65	16.148	7.0030	32.26
11.904	0.4307	8.00	18.454	8.0000	34.48
1 foot	0.4335	8.02	20.761	9.0000	36.58

a list of heads in inches and feet with their equivalent pressures in pounds per square inch, and also the corresponding velocities produced by these heads or pressures.

As sometimes very small velocities of flow may be met with, the following values of K in Eqs. (2 a) and (6 a) and their transpositions may be found useful,

$V = 0.4 \quad 0.5 \quad 0.6 \quad 0.7 \quad 0.8 \quad 0.9$ feet.
$K = 0.64 \quad 1.50 \quad 2.44 \quad 3.46 \quad 4.56 \quad 5.74$

COMPOUND AND BRANCH PIPES.

The solution of problems dealing with compound pipes and pipes with branches presents no special difficulties, although a little consideration of what is sought, and the best means of obtaining it, are necessary. When the velocity of discharge or the discharge are known beforehand, then the friction head or pressure for each section must be obtained by means of Eqs. (2 c) or (6 c), their sum being the total head or pressure required for producing the discharge, while any surplus is the available effective head or pressure. If no velocity is given, and no effective head is to be reserved, then a discharge must be assumed, and the friction head calculated for each section for this assumed discharge. The real head for each section is then obtained by the proportion:

$$\left.\begin{matrix}\text{Sum of}\\ \text{assumed}\\ \text{heads}\end{matrix}\right\} : \left\{\begin{matrix}\text{Assumed}\\ \text{head for}\\ \text{one sec.}\end{matrix}\right\} :: \left\{\begin{matrix}\text{Total}\\ \text{real}\\ \text{head}\end{matrix}\right\} : \left\{\begin{matrix}\text{Real head}\\ \text{for same}\\ \text{section.}\end{matrix}\right\}$$

From the real heads obtained in this way the real velocities and discharge are then easily obtained. The formulæ already given are all that are needed for working out any of these problems, as will be seen by the following example:

9. Given a pipe in two sections, one 6,076 feet long and 12 inches diameter, the other 2,413 feet long and 8 inches diameter, what will be the discharge with an initial pressure of 55 pounds?

Here $Fp = P = 55$ pounds.

$d_1 = 12$ inches, and $d_2 = 8$ inches.

$L_1 = 6{,}076$ feet, and $L_2 = 2{,}413$ feet.

Assume any discharge, say, 150 cubic feet, then by Table I,

$$v_1 = \frac{150}{47.1} = 3.18, \text{and } k_1 = 54.5;$$

$$v_2 = \frac{150}{20.94} = 7.16, \text{and } k_2 = 239.$$

We now have by Eq. (6c)

$$p_1 = \frac{54.5 \times 6{,}076}{12 \times 2{,}768} = 9.96 \text{ pounds};$$

$$p_2 = \frac{239 \times 2{,}413}{8 \times 2{,}768} = 26.04 \text{ pounds}.$$

The total pressure required for the assumed discharge is therefore 36 pounds. We then have

$$P_1 = \frac{55 \times 9.96}{36} = 15 \text{ pounds};$$

$$P_2 = \frac{55 \times 26.04}{36} = 40 \text{ pounds}.$$

Now, inserting these values of P_1 and P_2 in Eq. (6a) we have

$K_1 = \dfrac{12 \times 15 \times 2{,}768}{6{,}076} = 82$, and $V_1 = 4$ feet,

and $K_2 = \dfrac{8 \times 40 \times 2.768}{2{,}413} = 367$, and $V_2 = 9$ feet.

The discharge is therefore $47.1 \times 4 = 188$ cubic feet, or $20.94 \times 9 = 188$ cubic feet.

It may be sometimes found that the velocity of flow in the smaller pipe of a compound main is too great. In such case a suitable velocity should be determined upon, from which the diameter of the corresponding pipe is then calculated. As this will necessarily be larger, less friction head or pressure will be absorbed, so that there will remain an effective head serving for power purposes or to raise the water above the point of discharge.

In the case of pipes with branches, each of which is to discharge a certain volume of water, the problem generally is to find suitable diameters for the different pipes. The following example shows how simple is the method of procedure:

10. A main pipe A, 1,000 feet long, with 4 feet head, has a branch pipe B, 200 feet long, with 1 foot head, and a branch pipe C, 200 feet long, with 1 foot head. B is required to discharge 15 cubic feet, and C 24 cubic feet. Find the diameters of the main pipe and branches.

Assume for A 7 inches, then by Table I., $V = \frac{49}{144} = 2.44$ feet, and $K = 34$.

By Eq. (2b),

$$d = \frac{34 \times 1\,000}{4 \times 1{,}200} = 7 \text{ inches},$$

so that this diameter is a suitable one.

For B to deliver 15 cubic feet, we have by Eq (2a),

$$K = \frac{d \times 1 \times 1.200}{200} = 6\,d.$$

Assume $d = 4$ inches, then $K = 24$, corresponding to a velocity of 2 feet, giving discharge $= 2 \times 5.2 = 10.4$ cubic feet, so that this diameter is not sufficient. Assume therefore $d = 5$ inches, then as before $K = 30$, and $V = 2.3$ feet, the discharge being $2.3 \times 8.2 = 18.9$ cubic feet, so that a 5 inch pipe for B will answer.

For branch C to deliver 24 cubic feet, we have as before $K = 6\,d$. Assume $d = 6$ inches, then $K = 36$, and $V = 2.5$ feet, while the discharge will be $2.5 \times 11.8 = 29.5$ cubic feet.

When assuming a diameter it is generally convenient to select one which will give a velocity of two to three feet, as this is in most cases suitable for water power installations or for the distribution of water. The diameter to be assumed is then got almost at sight from Table I. or III.

Some problems will naturally be a little more complex than the preceding ones, but a little study of what is given and what is sought will soon make the right method of solution apparent, while the formulæ and tables here given will meet all needs.

PIPES WITH DISTRIBUTED DISCHARGE.

If portions of the total discharge of a pipe are given out at various points along the line of pipe, the volume of water flowing per second in each succeeding section of the pipe will be smaller, producing diminished velocity and friction, and a reduction of the head or pressure necessary to produce the velocity and overcome the resistance in each succeeding section. The total head or pressure required to discharge a given volume of water from a pipe will therefore be less, if the discharge is distributed at a series of points along the line, than if it is all discharged at the end of the pipe. Just what this difference is can be easily calculated, if the pipe is divided into a given number of sections of equal length, and the discharge at each section is the same, as is pretty much the case of a water main laid in a street full of houses.

Reduced to formula, we have in place of Eqs. (2a and c) and (6a and c):

$$K_1 = \frac{H(\text{or } P) \times d \times c \times 1\,200}{L}, \quad (7)$$

and

$$H(\text{or } P) = \frac{K_1 \times L}{1{,}200 \times d \times c}, \quad (8)$$

where K_1 is the value of K corresponding to the velocity of flow in the first section, and c is a constant taken from Table V., corresponding to the number of sections.

TABLE V.

Number of Sections.	Value of c.	Number of Sections.	Value of c.	Number of Sections.	Value of c.
1	1.00	8	2.51	60	2.926
2	1.69	9	2.55	70	2.937
3	1.93	10	2.60	80	2.944
4	2.13	20	2.79	90	2.950
5	2.27	30	2.85	100	2.955
6	2.37	40	2.89	200	2.977
7	2.45	50	2.91	1000	3.000

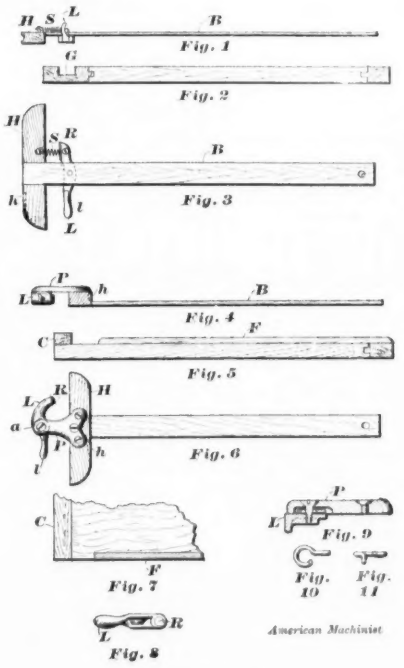
Having obtained by Eq. (7) the value of K_1, the corresponding velocity is obtained from Table II. and the discharge from Table I. When the discharge is given the process is reversed, the friction head being obtained by Eq. (8) If instead of head in feet, pressure in pounds is required, proceed in the same way, but use the constant 2,768 instead of 1,200 in Eqs (7) and (8).

If the end discharge of a pipe is known, and it is required to ascertain the total discharge if distribution is made at equally distant points along the line, the following should be used:

$$\left.\begin{matrix}\text{Total discharge}\\ \text{of all the sections}\end{matrix}\right\} = D \times \sqrt{c}. \quad (9)$$

Dividing this result by the number of sections then gives the discharge per section.

It may interest some readers, perhaps, to work out the values of c, to find how they are obtained; it will enable them more fully to appreciate the effect of this distributing by the wayside.



Tee-Squares.

By Oberlin Smith.

Several years ago, in conjunction with Prof. J. B. Webb, who was then associated with me, I came to the conclusion that though man was a two handed animal, in order to properly handle the conventional draftsmen's square, together with the triangle and pencil that are often used in connection therewith, a draftsman should be more than a man, inasmuch as he should possess at least three hands.

The result of these cogitations was a drawing board made as shown in front view in Fig. 2, upon which was mounted a special tee-square, as shown in front view, Fig. 1, and top view in Fig. 3. The general idea originated, as I remember, with Professor Webb, but was worked out by both of us. The only new feature in the drawing board is a groove G near the left hand end about one inch wide and, perhaps, three eighths inch deep. Beneath the blade of the tee square B was pivoted the lever L, the front end of which projected above the drawing board as shown in Fig. 1, and the rear end of which was pulled toward the head of the tee-square H by the spiral spring S, hooked on to two ordinary round-head wood screws, inserted in the head and lever respectively.

Cemented to the working end of the lever was a small pad of rubber R, whose function it was to give more friction against the left side of the groove G, when the square was down in place and the lever freely sliding therein. A flat spring, attached to the side of said lever and abutting against a pin projecting downward from the square blade, would, of course, have been as good and somewhat neater. The cheapest way of all would be to hook an ordinary rubber band over the screws, in place of the spiral spring S, but in those days these useful little bands were more of a curiosity than now.

The action of this square is self-evident, inasmuch as the head is firmly clamped against the left edge of the drawing board by the action of the spring and lever, instead of being held there by hand, thus leaving the two hands of the draftsman free to use his triangles, pencils, pens, etc., against the rear edge of the blade. The movement of the square forward and rearward upon the board is obviously as quickly performed as with the ordinary tee square, as it is just as easy to grasp the slightly indented head with the fingers of the left hand at h, with the thumb upon the lever at l, at the same time giving a slight pressure to overcome the spring and release the square, as it is to grasp the head of the square itself. In cases where the drawing board lies down flat upon a table the square is indeed easier to grasp than usual, as the fingers do not have to be thrust beneath it. This is a device that can be cheaply applied to any tee-square already in use, providing the drawing board upon which the same is to be mounted will permit, without too much weakening, the planing out of the groove G. If desired, this groove can be made under cut on the left side, in dovetail fashion, so as to give a holding down effect upon the square, but in practice we do not find this necessary.

In Fig. 5, in front view, and in Fig. 7, in partial top view, is shown a somewhat different type of drawing board, which I have adopted in recent years for my entire equipment. It requires no groove, and the left end is strengthened simply by screwing fast to it the cleat C. Incidentally, but having no connection with the use of the tee square, it may be mentioned that these boards are made with a flange F projecting upward from the front edge about one half inch high. This is often very convenient for preventing the tools from sliding off when the board is inclined, and more especially for resting the true front edge of the paper against in various cases of sketching and designing where it is not necessary to fasten it down, with thumb tacks or otherwise. In fact, nearly all our work is done with the paper thus loose, though possibly one reason why we do not feel the need of any fastening is that we use the cross ruled paper described upon previous occasions in these columns, not only for sketching but for all scale drawings.

The tee square used upon this board, in cases where not more than three feet of length is required, is shown in front view in Fig. 4, top view in Fig. 6, etc. It is made like an ordinary tee square, but with its head reversed, so that it projects upward from the blade and so that its left side slides against the right side of cleat C. To this cleat it is firmly held by the iron lever L, provided with a rubber pad R at its rear end, consisting of an ordinary rubber cork inserted in a drilled or cored hole. This lever, of course, presses against the left side of C, thereby clamping the square in any desired position. It is released by pinching the front end at l with one or more of the fingers of the left hand, the thumb resting in a slight indentation h at the right side of the head H. In Fig. 8 is shown a right view of the lever and rubber pad. In Fig. 9 is shown a front vertical section of lever L and a plate P. This latter is fastened to the top of the square with ordinary wood screws, and to it is pivoted the lever by a machine screw.

The actuating spring is a simple piece of bent wire shown in section in Fig. 9, in top view in Fig. 10, and in right view in Fig. 11. The straight end of this spring lies loosely in a groove cast in *P*, while the bent down end enters a rough hole cast in *L*.

As will be seen, the whole construction is very cheap, as the plate *P* may have the countersunk holes, etc., cast in it, the only fitting up being the tapping of the lever, together with a little grinding and japanning. It will be noticed that the pinching point between the lever and square is somewhat to the rear of the center of the head thereof. This is done to give more leverage to resist a forward action in the blade caused by its weight, and the weight of other tools resting against it, in cases where the board is inclined.

After several years experience I would in no case return to the old-fashioned method of handling a tee-square, nor would, I believe, any of the draftsmen who have been associated with me in the use of these important but simple tools. Of course, a square blade which is kept in rigid parallelism at both ends, by positive mechanical means, is still better; but it is correspondingly complex. Practically, I have found the devices described sufficiently good for short lengths of blades. For anything over three feet, however, I prefer the Bergner method of operating a square blade which, as is generally known, consists of a system of pulleys and cords at the ends of and beneath the drawing board, so arranged that the movement given to one end of the blade will pull the other end in the same direction. It happens, by the way, that this device was original with me, as well as with Mr. Bergner, although he thought of it first, and secured the patent thereon, I not knowing, at the time I made my first one, that he had done so. On large boards I have found that elastic steel wire, working around pulleys of comparatively large diameter, is superior in accuracy to the twine and small pulleys used in the Bergner system.

Proposed International American Exhibitions.

Our enterprising contemporary, *Dixie*, has conceived and is pushing a scheme for holding a series of international exhibitions in various South American countries. It has received from a large number of manufacturers expressions of opinion regarding the desirability and possibilities of such exhibitions, the general opinion being very favorable to the enterprise. The influence of President Diaz has been enlisted on behalf of the plan, and it seems probable that the first exhibition may be held in the city of Mexico some time in the not distant future.

The idea is to make these exhibitions not "world's" affairs, but to confine them to what are called "The Americas," the prime object being, of course, to promote trade between ourselves, and the nations to the south of us. The object is undoubtedly a good one, and we shall hope it will succeed. Our contemporary invites expression of opinion upon it by manufacturers, and can be addressed at Atlanta, Ga.

Mass Meeting of Stationary Engineers.

There will be a mass meeting of the stationary engineers of New York and vicinity at the hall of the Young Men's Christian Association, Twenty third street and Fourth avenue, on the evening of Tuesday, October 30th, under the auspices of the Bureau of Education of the National Association of Stationary Engineers. The purpose of the meeting is to explain the system of education adopted by the recent convention at Baltimore, and to instruct the members how to derive the most advantage from it. All engineers are cordially invited to be present.

In our issue of November 27, 1890, we gave an account of the new battleship "Maine," which was launched on the 18th of that month at the Brooklyn Navy Yard, where the hull was built, the engines having been built by the Quintard Iron Works, this city. On the 17th inst. a trial run of the vessel was made on Long Island Sound, the main object of which was to determine the maximum horse-power the engines are capable of developing. At this writing the data of the run have not been collected and results computed, but enough is known to make it reasonably sure that the stipulated 9,000 horse power will be exceeded somewhat, and that a premium will, therefore, be earned by the engines' builders. The engines are reported as working admirably at "concert pitch," and Commodore Melville, who was aboard during the run, expresses himself as well pleased with them. The vessel, though in water too shoal for high speed, moved at the rate of about 17.25 knots, 17 knots being her designed speed. In the issue referred to above will be found full particulars regarding the vessel.

The Rapid Transit Commission of New York City sent Engineer Wm. R. Parsons abroad to study intramural railways, and he has recently made a preliminary report, his conclusions being as follows:

First—That an underground railway operated by steam, even with the most approved system of mechanical ventilation, would be intolerable to the people of the city of New York.

Second—That a railway with a steady, frequent service can be operated successfully and economically by electricity.

Third—That an underground railway operated by electricity has a comfortable atmosphere, and that it can be arranged so as to avoid great changes in temperature.

Fourth—The advice and experience of foreign engineers lean toward keeping the rail level as close to the surface as possible, and that excavating from the surface is cheaper and safer than tunneling; but

Fifth—If conditions demand, a deep tunnel can be constructed, for which the circular form is the best.

Sixth—That an underground road can be so designed as to be attractive in appearance.

Seventh—That the work can be carried on through a busy street without endangering the houses and without seriously impeding travel.

MANUFACTURES.

The Waterous Engine Co., St. Paul, Minn., will erect a new machine shop of wood and iron to cost $25,000.

The Columbia Railway Company is about to build at Washington, D. C., an 80x200-foot power plant.

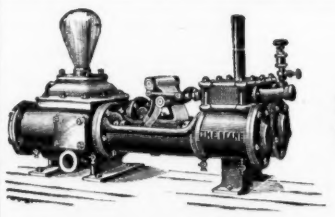
The Ames Iron Works, of Oswego, N. Y., report business in engines considerably better than for some months past.

The Chapman Valve Company will build a $9,000 addition to its foundry at Indian Orchard, Springfield. Into this addition $16,000 worth of machinery will be placed.

The capital of the Vitrified Wheel Company, of Enfield, Conn., has been increased from $60,000 to $100,000, and the number of shares to 400. Of the increase 20 per cent. has been paid in in cash.

The Conover Mfg. Co., of New York, have taken an order through the Watts-Campbell Co., engine builders from the Consolidated Traction Co., Newark, N. J., for three Conover independent condensers, each being 1,500 horse-power. Mr. Conover reports a material improvement in business of late.

Whitfield P. Pressinger, who published a short time ago a brochure on the "Widening Use of Compressed Air," has returned from Europe and



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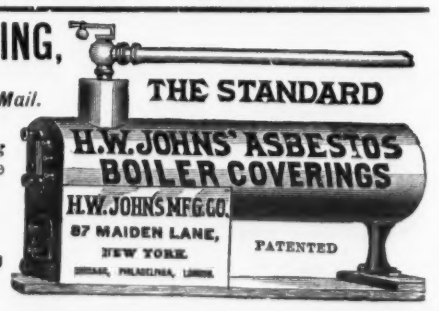
We're Proud Of!
And what's better, our customers are always highly pleased with our tools; the workmanship, material and finish are of the highest order, while our designs are the latest and most approved. We are quoting specially low prices just now. Our catalogue will tell you all about our tools—sent free.
SEBASTIAN LATHE CO.,
117-119 CULVERT ST., CINCINNATI, OHIO.

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.



connected himself with the Clayton Air Compressor Works, of New York, where his study of systems of air compression and transmission will be employed in the interest of the business.

We have received from the Brown & Sharpe Mfg. Co., Providence, R. I., a pamphlet designed to give an idea of what can be, and is done by them, in the way of formed cutters for milling. Excellent engravings are given of a variety of cutters and the pamphlet will be found to be of interest to all who have to do with milling machines.

Armstrong Bros. Tool Co., 76-78 Edgewood avenue, Chicago, write us: We find a steadily increasing demand for our tools, and from the way orders are coming in this month we would think that business is either improving very fast, or that it has got so low that the machine shops have got to economize in every way possible and cannot afford to use forged tools.

The International Mfg. Co., of Chicago, Ill., is a recent corporation organized for the purpose of manufacturing bicycles. They have just placed their order with the Lodge & Davis Machine Tool Co., of Cincinnati, O., for an outfit of machine tools adapted to the manufacture of bicycles, including engine lathes, sensitive drills, milling machines, screw machines and turret lathes.

We have received from J. W. Hampton, Jr., & Co., Custom House brokers, 41 Broadway, New York, a pamphlet giving foreign express and freight rates. It contains not only these, but tables of comparative weights and values of money in different countries, and will be found a great convenience to those who are doing, or expect to do, an export business. It is sent upon application.

Following is the language of the award to the Cleveland Twist Drill Co., of Cleveland, O., on their exhibit at the World's Fair, Chicago: "Most extensive exhibit and greatest variety of well-made twist drills, exhibited as they are manufactured and furnished to the trade. The workmanship on all of these drills is of the highest order, and especially meritorious are the twist drills in millimeter diameters."

Through their agents, the Providence Engineering Co., the Mason Regulator Co., of Boston, have installed during the past month the following boiler feed pumps in the city of Providence: American Electrical Works, No. 8 pump; Kent & Stanley Co., No. 6 pump; Continental Steamboat Co., two pumps; American Dagras & Chemical Co., Brownell, Field & Co., Providence Journal Co., Butman & Tucker.

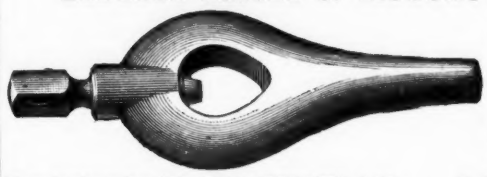
The Buffalo Forge Co., Buffalo, N. Y., write us that their business in Buffalo progressive lumber dryers is developing rapidly, and they are now sending them abroad, a recent order being for a large outfit to be shipped to Reval, Russia, for drying veneers. The parties ordering this outfit, after trying various plans of seasoning this material, with unsatisfactory results, investigated the above-named system and the order followed.

Recent sales of the Standard Water-tube Safety Boilers, by the Link-Belt Machinery Co., Chicago, have been made to the following parties. Plainwell Church Furniture Co., Plainwell, Mich., 100 horse-power; Mutual Electric Light and Power Co., Chicago, 600 horse-power; Pittsburgh High School, Pittsburgh, Pa., 250 horse-power; Institute for Feebleminded, Pittsburgh, Pa., 800 horse-power, and Detroit Chamber of Commerce, Detroit, Mich., 300 horse-power.

We have received from Baker & Co., gold, silver and platinum refiners, 408-414 N. J. Railroad avenue, Newark, N. J., a pamphlet containing data concerning platinum, etc., which will be found of use to manufacturers who are interested in any way in this metal. The catalogue contains illustrations of a large number of articles made of platinum, and has also tables giving weight per foot of platinum wire, decimal equivalents, comparisons of English and French measures, comparisons of wire gauges, etc. It is sent upon application.

The Tradesman, Chattanooga, Tenn., in its report on the industrial condition of the South for the week ending October 15th, says: Southern lumber interests are receiving needed attention. Organizations are being perfected with a view to promote better understandings between buyers and sellers, and to aid in obtaining remunerative prices. Cotton is coming into market in excellent condition; coal and iron are in active and increasing demand, and new textile mills and enlargements of existing ones continue to be reported. An advance in prices is only needed to make the South more prosperous than it ever has been. *The Tradesman* reports 38 new industries as established or incorporated during the week, together with nine enlargements of manufactories, and 15 important new buildings. Prominent among the new industries of the week are: A company with $500,000 capital, organized to develop mineral lands in North Carolina; a $200,000 cotton-mill at Winston, N. C; the Key West Light and Power Co., of Key West, Fla., capital $125,000; a $100,000 improvement company at Mobile, Ala., and the Horton Deep Water and Artesian Well Co., of Dallas, Texas, capital $100,000. A $60,000 cotton-mill is reported at Lincolnton, N. C.; a $50,000 cotton-mill at Rock Hill, S. C.; the Houston Pressed Brick Co., capital $30,000, has been chartered at Houston, Tex.; a boat-building company with $25,000 capital, has been organized at New Orleans, La., a $20,000 manufacturing company at Galveston, Texas, and a $10,000 pencil company at Charlottesville, Va. Cotton compresses, three in number, are to be built at Temple, Texas; cotton mills are reported at Jacksonville, Ala., and High Falls, S. C.; canning factories are to be built at Eagle Rock, N. C., and Memphis, Tenn.; flouring-mills at Magazine, Ark., and Roxie, Va.; a tannery at Buford, Ga.; tin plate-mills at Birmingham, Ala., and Louisville, Ky.; tobacco factories at Fulton, and Owensboro, Ky.; and wood-working plants at Lakeland, Fla.; Gulf, N. C.; New Albany, and Greenwood, Miss.; Winston, N. C.; Dickson, Tenn.; Hampton and Petersburg, Va., and Central City and Matewan, W. Va. *The Tradesman* also reports water-

REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

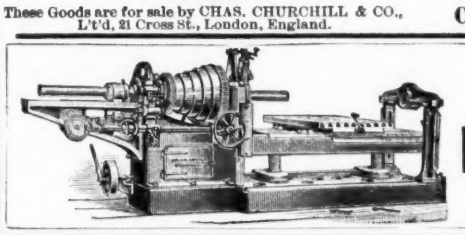


To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

C. W. LeCOUNT, South Norwalk, Conn.



BETTS MACHINE CO.,
WILMINGTON, DEL.
MACHINE TOOL BUILDERS.
Improved Patterns! Late Designs!

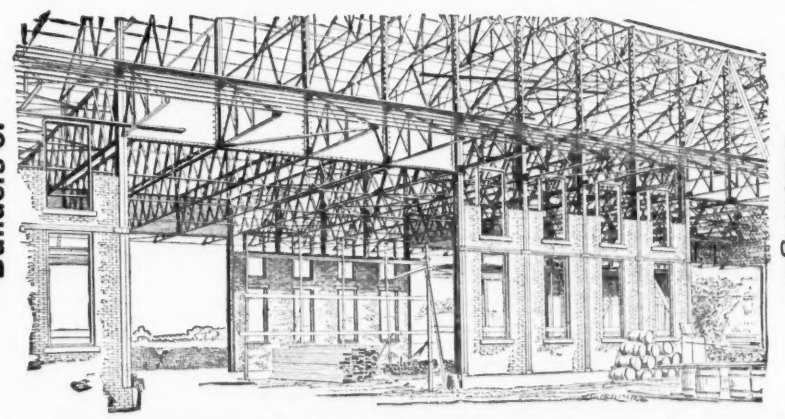
DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON.
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

EVERY MACHINIST SHOULD HAVE A COPY OF
OUR CATALOGUE.
It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over.
MONTGOMERY & CO.,
105 FULTON STREET, NEW YORK CITY.

"Star" Foot Lathe Swings 9x25 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
Catalogue Free of all our Machinery.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N.Y

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.

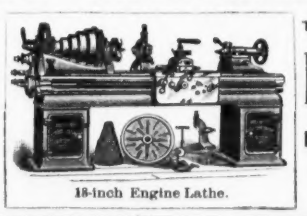


The above illustration is taken direct from a photograph, made during the construction, and shows the details of an Iron Building designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 60 feet in width by 320 feet in length, and is two stories high—the lower floor being used as a Ship Shed for punching, bending, riveting, etc.,—the upper floor being used as a Mold Loft. Outside of the building, extending entirely around it on all four sides, is an overhang 12 feet wide, thus affording additional shop room outside of the building, where raw material may be stored and still be protected from the weather. Wide openings are placed every 40 feet so that raw material may be taken in, and finished product moved out, cheaply and quickly. The supporting frame is all iron throughout, and between the iron posts on the sides is a light brick wall.

SEND FOR OUR ILLUSTRATED CATALOGUE.

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

FITCHBURG MACHINE WORKS,
MANUFACTURERS OF
FITCHBURG MODERN AND OTHER
SEND FOR CATALOGUE E



18-inch Engine Lathe.

THE CELEBRATED
ENGINE LATHE
METAL-WORKING MACHINES
FITCHBURG, MASS.

BUILDERS IRON FOUNDRY,
(Patented.)
PROVIDENCE, R. I.

GLOBE SPECIAL CASTINGS FOR WATER-WORKS, MILLS AND RAILROADS.
"I think they are the most practical special in use at the present time."
All common sizes in stock. Catalogue mailed on application.
M. J. DRUMMOND, SALES AGENT, 192 BROADWAY, NEW YORK CITY.

CHATTANOOGA DOUBLE STRENGTH
WOOD SPLIT PULLEYS.
Lighter, Better and Cheaper than Iron.
Oval Bushings, Nailed Segments.

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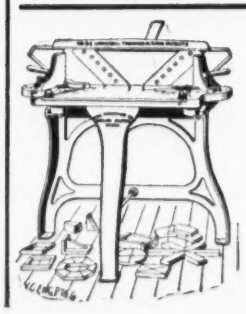
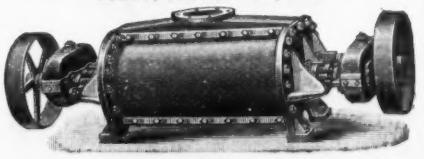
COOKE & CO.,
163 & 165 Washington St.,
NEW YORK.
MENTION THIS PAPER.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

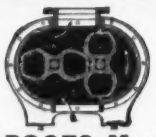


THE NEW FOX
Universal Trimmer
is the only one that has an accurate adjustment of the gauges. Cannot be set wrong. Work must be correct. Time saved in Pattern-making and all wood-working.
CATALOGUE FREE!
FOX MACHINE CO.,
325 Nor. Front St., Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

ROOT'S FORCE BLAST ROTARY BLOWER.
For FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.



SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.



BEST MECHANICAL CONSTRUCTION.
P. H. & F. M. ROOTS, Manufacturers,
CONNERSVILLE, IND.
Chicago Office: 1405-10 Manhattan Building.
S. S. TOWNSEND, Gen. Agent. } 163 & 165 Washington St.
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In Writing Please Mention This Paper.

WORTHINGTON
PUMPING ENGINE
FOR
WATER WORKS.
SIMPLE, COMPOUND, OR TRIPLE EXPANSION, HORIZONTAL OR VERTICAL
HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

works at Apalachicola, Fla., and Abbeville, S. C. The enlargements for the week include a corn mill at Columbia, Tenn.; engine works at Bristol, Tenn: a can factory at Roanoke, Va.; an oil-mill at Forsyth, Ga.; a shoe factory at Piedmont, Ala.; cotton-mills at Tuscaloosa, Ala.; Charlotte and Raleigh, N.C., and a tobacco factory at Statesville, N. C.

Machinists' Supplies and Iron.

NEW YORK, October 20, 1894.

Iron—American Pig—We quote standard brands, $12.50 to $13 for No. 1; $11 to $12 for No. 2. Southern brands, $11.50 to $12 for No. 1; $11 to $11.25 for No. 2; $10.65 to $10.75 for No 3; $11.15 to $11.25 for No. 1 soft; $10 90 to $11 for No. 2 soft. Foundry No. 4, $10 to $10 40.

Antimony—We quote L. X., 8¾c to 8½c.; Cookson's, 9½c to 9¾c.; Hallett's, 7⅝c. to 7½c.; and U. S. French Star, 9¼c. to 9⅛c.

Lard Oil—Prime City we quote at 61c. to 63c

Copper—The market is weak with a tendency towards lower prices. Lake Copper has lately been sold at 9.70c. and can be bought at 9.60c. from second hands. Casting Copper is held at 9.25c.

Lead—Holders are more free in their offerings, but do not easily attract buyers. For New York delivery 3½c. is quoted for October and 3.10c. for November

Spelter—The market is dull. For New York delivery 3.45c. is quoted. The demand continues exceedingly small.

Tin—The market is steady. Stock has been reduced considerably during the week. For spot 15.30c. is asked.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Draftsman, grad., 6 years' exp. in eng. and boiler work, wants position. Box 7, AM. MACHINIST.

Constructor and inventor, printing presses, spe'l mach'y, open for contr't Jan.1st. H.C.F., AM.MACH.

Situation wanted by first-class general machinist. Address Machinist, 63 Seventh street, Troy, N. Y.

Wanted—Sit. by pat. mkr. (machine); good refs. H. C. Wernitz, 416 Baker avenue, Evansville, Ind.

Wanted—Situation by graduate of Sibley College in Mechanical Engineering, Junior of American Society. Address Sibley, care of AMER. MACHINIST.

Mech. eng'r with 12 years practical experience in designing of steam and general mach'y, member of A. S. M. E., is open for pos. Box 37, AM. MACH.

Wanted—Mechanical, electrical, civil engineers, draftsmen; professional work for spare time; liberal pay. Edwin Guthrie, Washington, D. C.

Wanted—A partner with $3,000, to take half interest in an established machine and repair shop; have several good patents; must be a practicable machinist, and capable of taking charge of shop. Address Partner, care AMERICAN MACHINIST.

Wanted—An experienced mill inspector by a manufacturer of high-grade crucible steel; one competent to inspect closely and critically tool steel, drill rods, forgings, cold rolled steel, etc. Only a man whose fitness for the position is attested by the best refs. need apply. Inspector, AM. MACH.

Chief draftsman and designer, competent and efficient, a varied and extensive experience, and thoroughly versed in American and foreign practice, owner of several val. patents, pertaining to steam engineering, seeks a change, and will negotiate with principals only. Box 36, AM. MACHINIST

Wanted - Foreman familiar with turret lathes and latest methods for duplicating parts of machinery rapidly and cheaply; give full name and experience, applications with first-class references only will be considered; good opening for man of ability and energy. Address Box 39, AMER. MACH.

Wanted - A salesman who has handled the highest grades of English crucible steels through the New England States, to introduce in that territory an American steel of equally high grade; only one who has had extensive trade and long experience need apply. Crucible Steel, AMERICAN MACHINIST.

Wanted, competent foreman—Large well equipped machine shop; general line of work; he must thoroughly understand drawings and the handling of men and be well experienced generally; competent to make estimates, lay out work, etc; must not be above taking advice when necessary; would prefer him to work as a workman 2 or 3 months to show his mechanical ability before he takes charge; give refs., age, full particulars. Box 38. AM MACH.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J

Wanted—To buy good second-hand tools. Box 83, AMERICAN MACHINIST.

Draftsmen's new conveniences for rapid work. Send for blue print. D. J. Kelsey, New Haven, Ct.

For Sale—Glass mold works and machine shop; good opportunity for the right man. T. W. Voelker, 233 Mill street, Rochester, N. Y.

Every mechanic should have a copy of "Pocket Primer of the Air Brake." Sent to any address for 50 cents. W. S. Rogers, Buffalo, N. Y.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

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ESTABLISHED IN 1874.

CLEVELAND TWIST DRILL CO.

100 and 102 Reade Street, New York.
85 Queen Victoria Street, London, Eng.
5 Neue Promenade, Berlin, C., Germany
Cor. Lake and Kirtland Streets, Cleveland, O.

DETROIT TWIST DRILL CO., DETROIT, MICH., U. S. A.

SOLE MANUFACTURERS OF

GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

Machine and Boiler Tools,

MODERN STYLE, AT LOW PRICES.

IRON PLANERS.
19 in. x 3 ft. Wheeler.
20 " x 6 " Pratt & Whitney.
22 " x 5 " Pease
24 " x 4 " Wood & Light.
24 " x 5 " New Haven.
24 " x 6 " Wood & Light.
26 " x 7 " N. Y. S. Eng. Co
27 " x 5 " Pond
30 " x 10 " Bancroft heavy A1
36 " x 8 " Pease.
60 " x 24 " Steam Eng. Co.

SHAPERS.
16 in. Stroke Gould & Eber.
22 " " Triple Geared.

DRILLS.
3 Spindle Slate Sensitive.
3 Spindle Hendey
20 in. Swing Wheel Feed.
20 " " Prentice, stand comp
25 " " Prentice complete.
40 " " Cinti. complete
Radial Drill, 86 in. complete.

MILLING MACHINES.
Brown & Sharpe No. 6 Plain.
Brainerd Plain Table 30 x 8.
Brown & Sharpe No. 1 Universal.
Lincoln Pattern, very cheap.
Garvin, No 2 and 4.

BORING MILLS.
Bement No. 2 Hor., B. & D.
Bement Cyl. Borer, 12 to 36 in.
Upright B. & T. Mill, 38 in.
Brown & Sharpe Upright Turret Borer, takes in 36 x 12 in.

ENGINE LATHES.
13 in. x 6 ft. Blaisdell.
14 " x 6 " Reed Taper.
15 " x 5 " Pond.
15 " x 8 " Standard.
16 " x 6 " New Haven.
16 " x 6 " Ames.
16 " x 6 " Putnam.
20 " x 10 " Fitchburg
20 " x 12 " Prentiss Taper.
22 " x 8 " Harrington
22 " x 10 " Putnam.
24 " x 12 " Putnam.
34 " x 8 " Putnam
35 " x 15 " Hewes & Phillips
36 " x 24 " Old Style cheap.
48 " x 17 " Hewes & Phillips.

HAMMERS.
50 lb. Helve, Bradley, Up g't.
800 " Steam, Ferris & Miles.

BOILER AND BRIDGE TOOLS.
Rolls, 7, 8 and 10 ft.
Hor. Flange Punch, "H and J."
Bement Plate Planer 16 ft.
Allen Pneu. Bridge Riveter with reach of 60 in.

MISCELLANEOUS.
Imp. Brass Cabinet Turret.
Acme, 1 in. Bolt Cutter with Dies, Nut Taps, Chuck, etc.
Slotters 10 and 18 in. Stroke
Stiles No 14 Adj. Press, weight 4,200 lbs. Good as new.
Screw Machine, 2 in. hole.
Screw Machine No 2. Wire feed

J. J. McCABE,

SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.

14 Dey St.,
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The "Eclipse" Drill, Tool and Graver Sharpener.

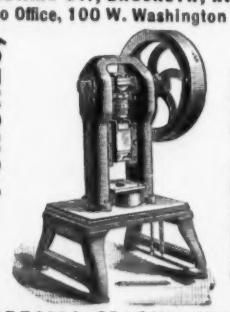
The only practical device for the re-sharpening of drills or any other tools requiring a flat surface and fine edge. It can be adjusted to any angle, and by aid of the degree or index marks the drill or tool can be set to the desired angle almost instantly.

Price, Size A $1 75, sent post paid on receipt of price.

EZRA F. BOWMAN & CO.,
22 E. Chestnut St., Lancaster, Pa.

E. W. BLISS CO.
1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 100 W. Washington Street.

PRESSES, PUNCHES, SHEARS, DIES, DROP HAMMERS,



SPECIAL MACHINERY.
The STILES & PARKER PRESS CO.

MACHINERY BARGAINS.

10 in. Post Drill.
10 " " Auto. Feed to Table. for Butt Drilling.
1, 2 and 3 Spindle Sensitive with and without Power Feed.
2, 3 and 4 Spindle Gang Drills
20 24, 26, 28, 30 and 44 in. "
60 in. Swing Post Drill.
5 ft. Arm Radial Drill.
12 in. Stroke, 16 in. x 16 in. Crank Planer.
16 in. x 4 ft. Planer.
24 " 4, 5 and 6 ft. Planer.
28 " 5 and 8 " "
30 " 5, 8 and 10 " "
60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
10 in. Stroke Slotter.
Hyd. Rivetting Machine.
" Crane, Both A1.
Punch and Shear.
Plate Planer.
Hor. Flange Punch No. 2 H. & J.
Thomson Bevelling Shear.
15 " 6 and 8 ft. Eng. Lathe.
16 " 5 6, 7 and 10 ft. Eng. "
18 " 6 7 and 8 " "
20 " 5, 6, 7, 8 and 10 ft. " "
21 " 10 and 13½ ft. " "
24 " 10 " " "
25 " 16 and 24 " " "
32 " 16 " " "
52 " 35 " " "
57 in. Double Head Driving Wheel Lathe.
88 in. x 20 ft. Engine Lathe.
Bement Car Axle Lathe.
1¼ & 2 in. Bolt Cutter Schenk's.
7 Spd'l Nut Tapper, Dunel.
2 Spd'l Profiler. No. 1 P & W.
No. 1, 2 and 2½ Screw Machs P. & W.
No. 1 Lincoln Pattern Miller.
Hand Millers, Screw Slotters Mill and Cutter Grinders.
No. 2 Garvin Universal Miller.

Lot of Miscellaneous Machinery, Engines, etc. Send for Latest List.

GEO. PLACE MACHINE CO.,
Offices: 145 BROADWAY and 86 LIBERTY ST.
Warehouse: 511 and 513 WEST 13th STREET,
NEW YORK.

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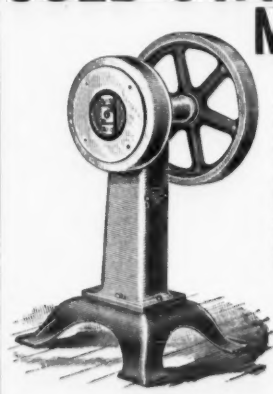

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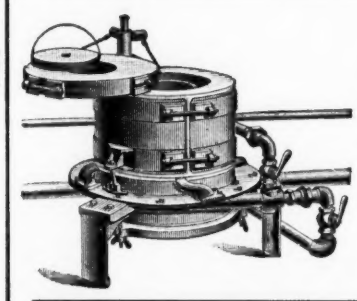

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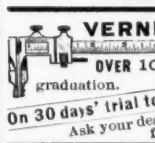

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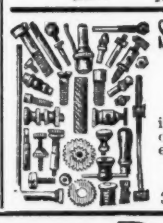

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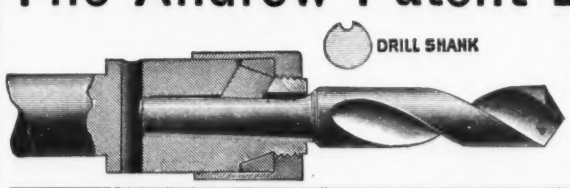

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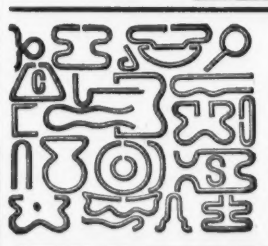

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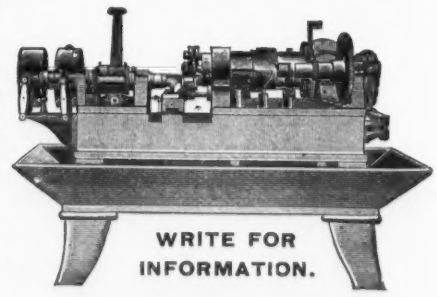

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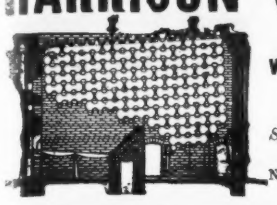

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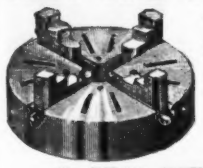

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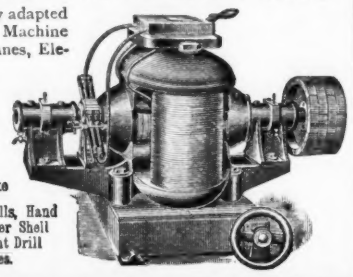

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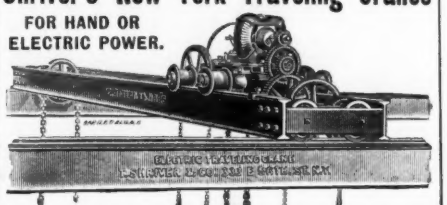

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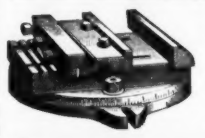

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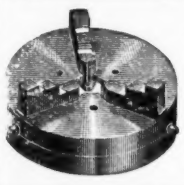

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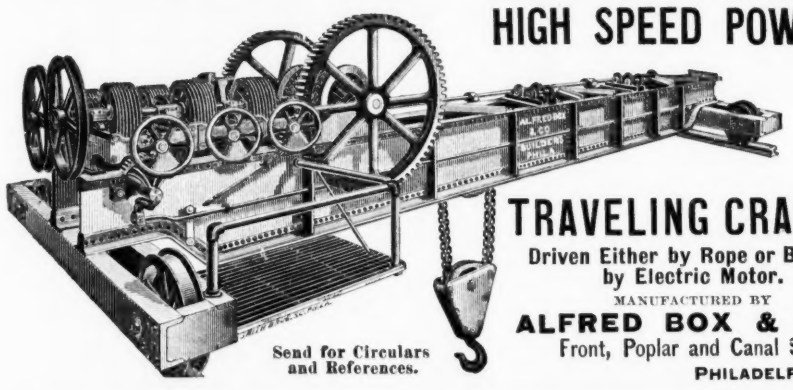

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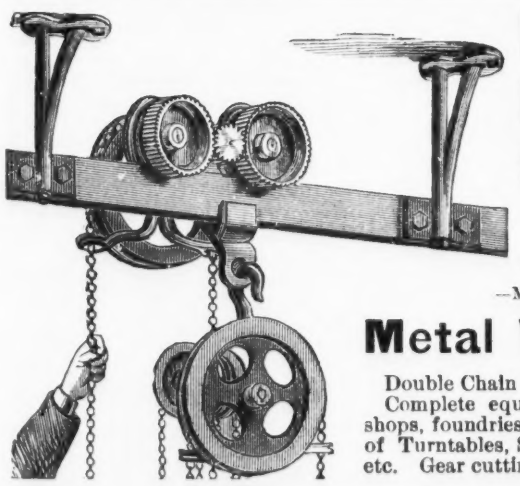

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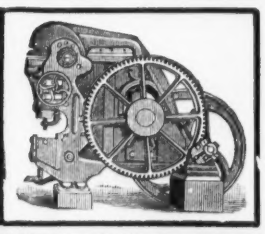

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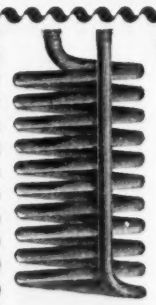

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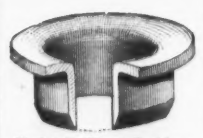

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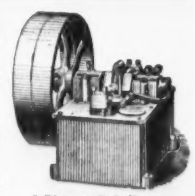

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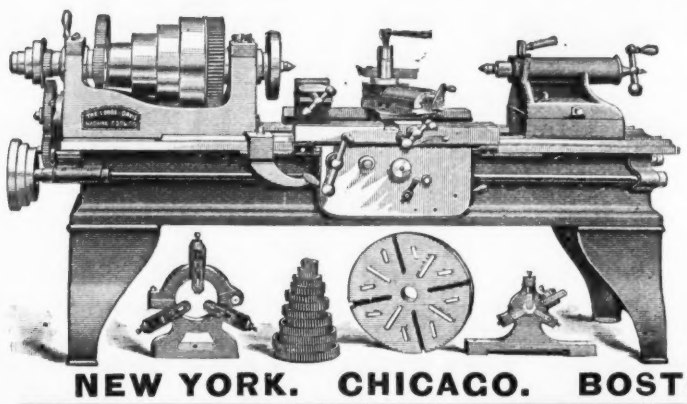

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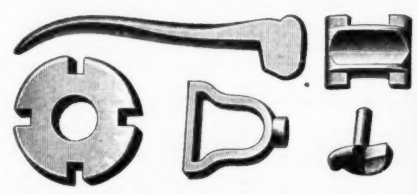

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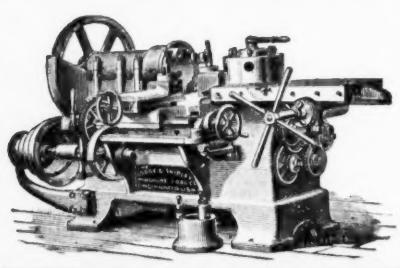

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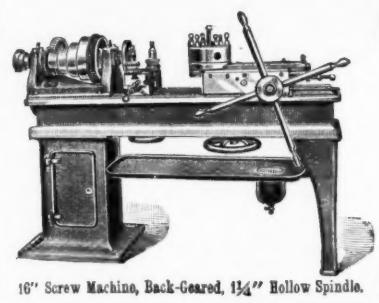

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Can be attached or removed in a few seconds without injury to shaft or coupling. Send for discount and illustrated Price List of 40 sizes.

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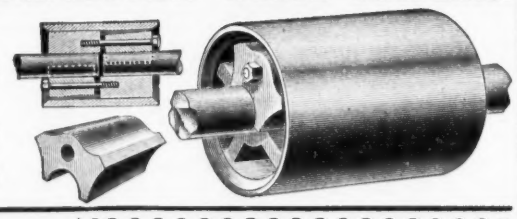

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7 SIZES. LATEST DESIGNS.

We show a better record than all other houses combined. Let us tell you all about it.

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ELECTRICAL
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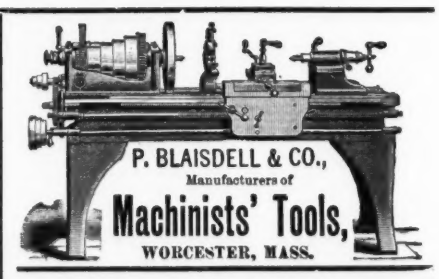

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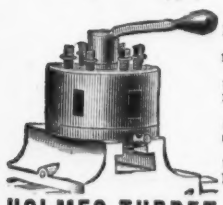

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"As it takes regular lathe tools there is no expense in fitting up for ordinary jobs."
"Frequently makes the engine lathe the equal of a screw lathe."
If your dealer don't handle them we will send C. O. D. prepaid east of Missouri river.

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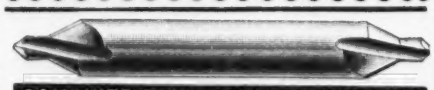

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Manufacturers of Set, Cap & Machine Screws, Studs, etc.

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the speed of the traverse (or feed) of emery wheel should be variable to anything between extremes. Our Grinding Machines are arranged to do this instantly without changing belts. Machines guaranteed.

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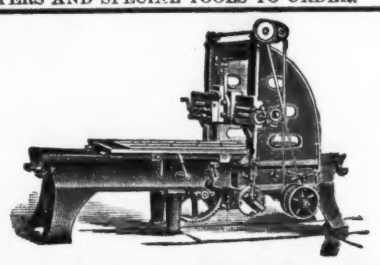

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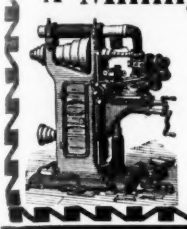
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.

A Milling Machine or . . . .



a Cutter and Tool Grinder.

If you need either, and where is the shop that doesn't? write

The Cincinnati Milling Machine Co.,

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NEW LINE OF ENGINE LATHES.

DRAPER MACHINE TOOL CO.

SUCCESSOR TO LATHE & MORSE TOOL CO.

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FOR SALE.

Two second-hand 4½" cutting-off machines, made by Pratt & Whitney, in good condition and price very low. Also two second-hand 4" Hurlbut & Rogers machines in good condition and bargains for the price.

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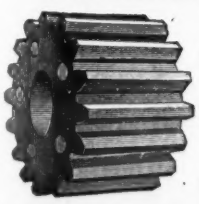
STRANGE, BUT TRUE!!

The New Process Raw Hide Gears

ASTONISH THE MACHINERY WORLD.



They **Outwear any Metal.**

They require **No Lubricant.**

They are **Noiseless and Clean.**

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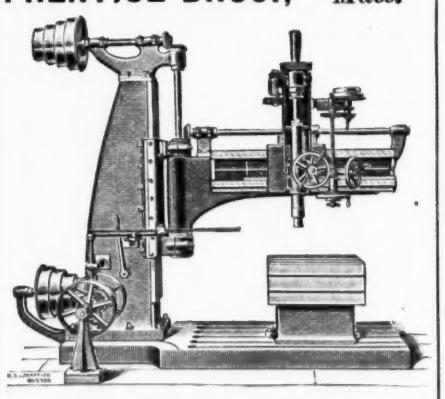

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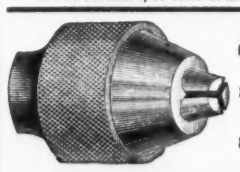

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The No. 4 B Machine for Cutting and Threading Pipe ⅛ in. to 4 in., by HAND or POWER.

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The only one. Saves annoyance. Saves labor.
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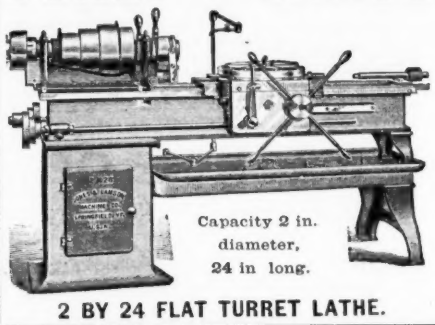

Capacity 2 in. diameter, 24 in long.

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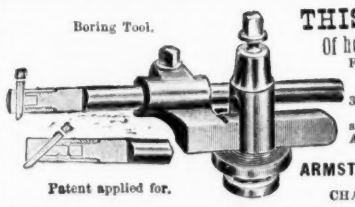

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Of how these tools gain in favor after being once tried.

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Both Hand and Power.
Sizes 1 to 6 inches.
Water, Gas, and Steam Fitters' Tools, Hinged Pipe Vises, Pipe Cutters. *Stocks and Dies universally acknowledged to be* THE BEST. *Send for catalog.*

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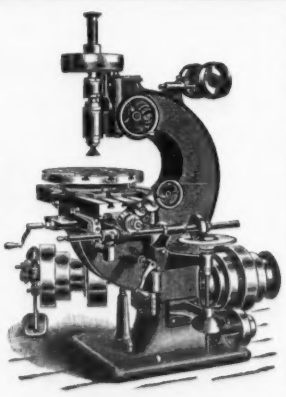

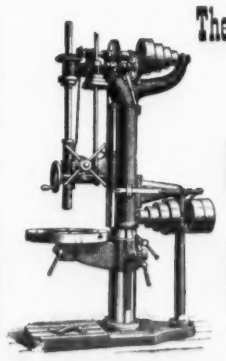

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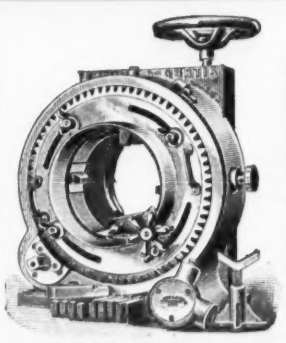

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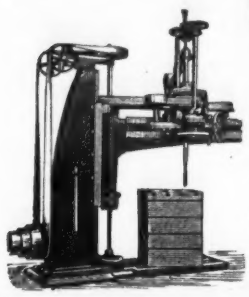

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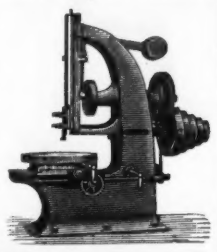

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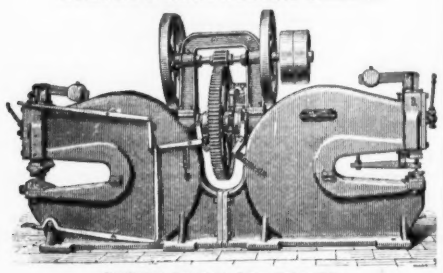

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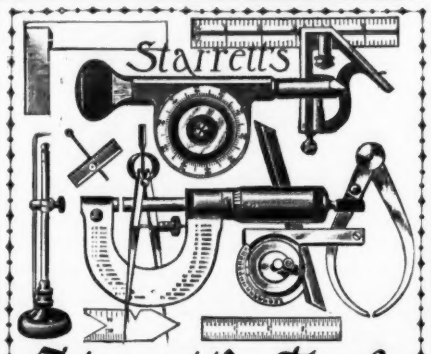

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MANUFACTURERS OF THE
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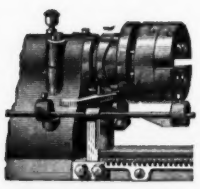
Automatic Bolt-Threading and Nut-Tapping Machine.
Made in all Sizes to Cut from 1-4" to 6".



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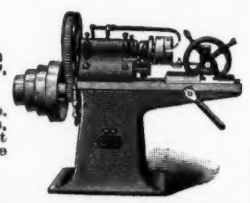

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Graduated in 8ths, 16ths, 32ds and 64ths.

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4 "	30	3 "	25

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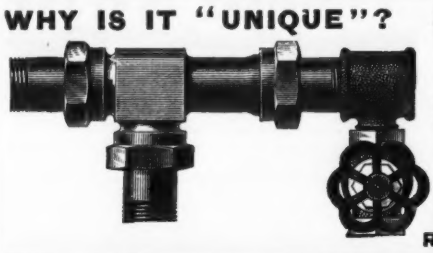

BECAUSE IT COMBINES SO MANY GOOD POINTS.
It requires no change for varying pressures of steam, can be placed in any position, is simple in construction, conveniently come at for cleaning, and all valves or other fittings required are such as can be had of any dealer.
Do you want to know more about Rue's "Unique" Single Tube Injector?
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PENBERTHY INJECTOR CO. MFRS, DETROIT, MICH.

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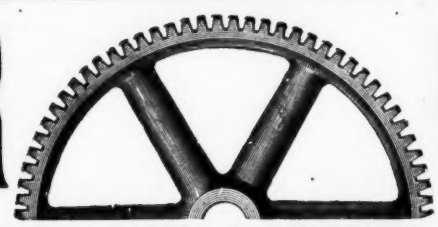

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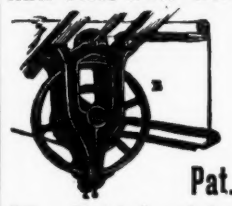

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MARKING MACHINE,
For rolling trade-marks on flat or round Iron or Steel surfaces.
Used by Cutlery, Pistol, Twist Drill, Wrench, and many other mfrs.
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Saws made in two sizes Nos. 1 and 2 Cut 4½ to 8 inches. Send for circulars to
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SPECIAL FACILITIES FOR THE
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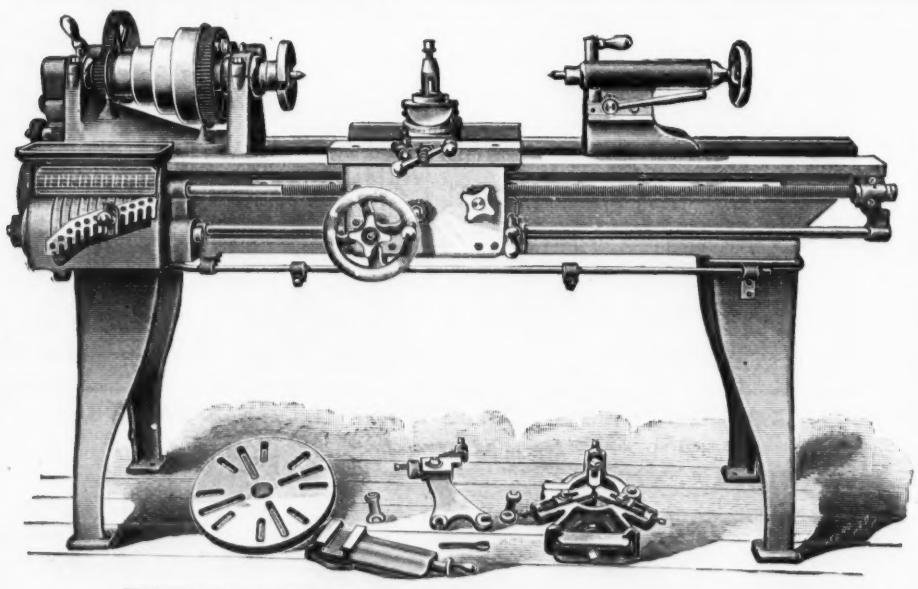

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THIS Lathe COMBINES the LATEST and BEST Improvements. Automatic Stop. It is Simple, Durable, Indispensable. It will AUTOMATICALLY STOP the Carriage in EITHER direction. It is equally efficient whether FEEDING or THREAD-CUTTING. Running up to a shoulder, boring to BOTTOM of holes, or INTERNAL THREAD-CUTTING. No danger of spoiling either tool or work. It is a safeguard against accidents, in either direction.

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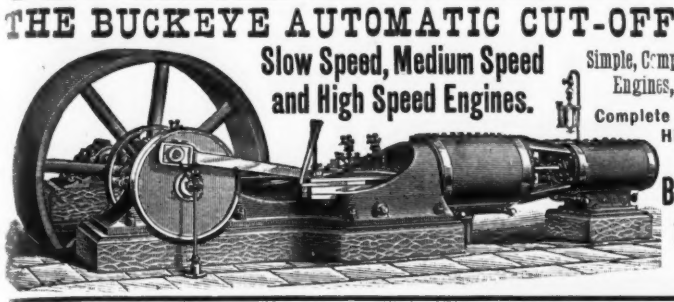

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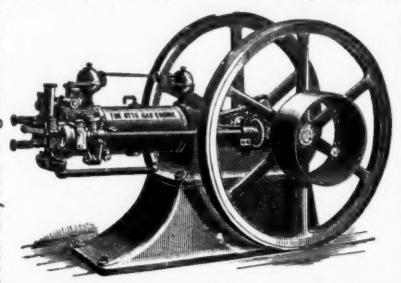

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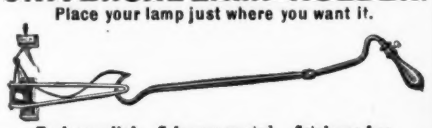

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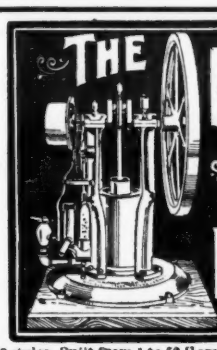

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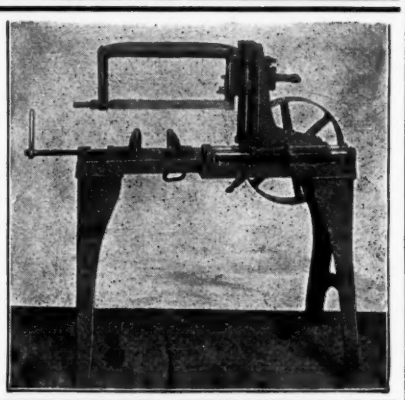

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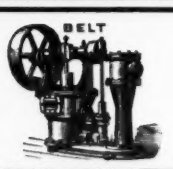

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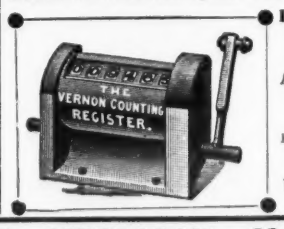

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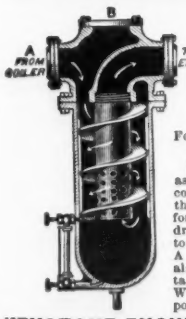

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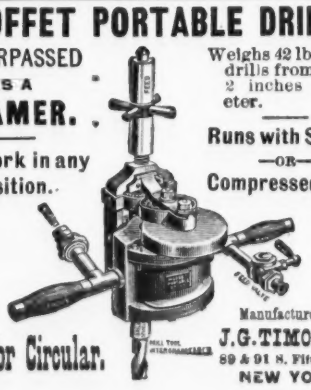

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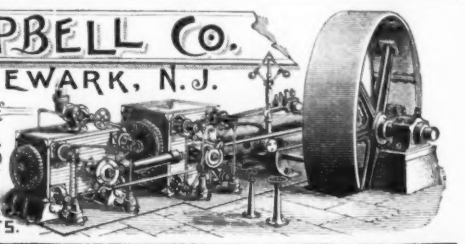

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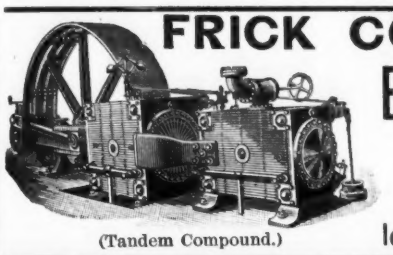

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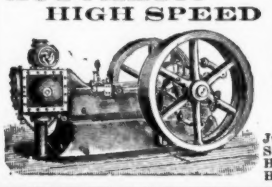

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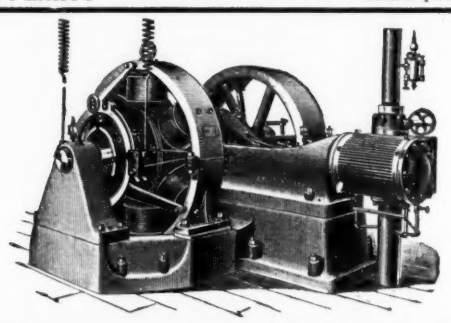

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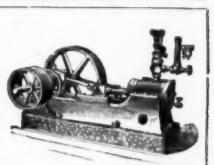

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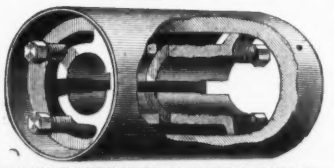

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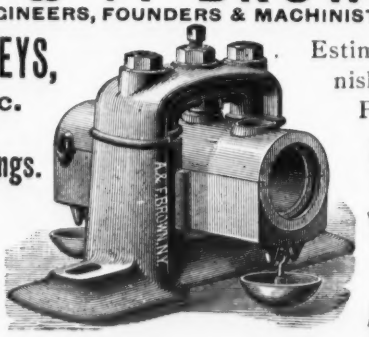

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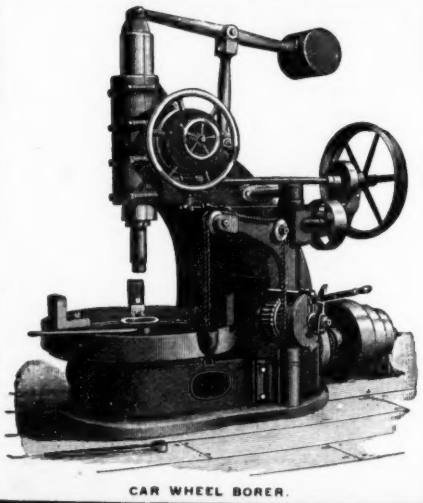

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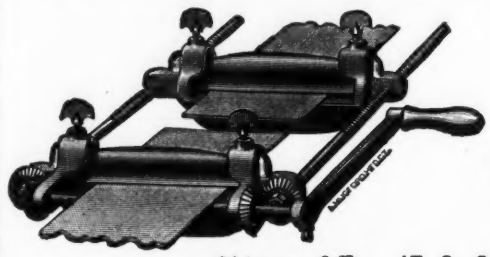

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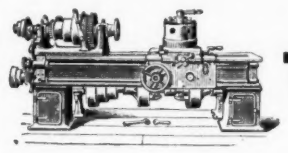

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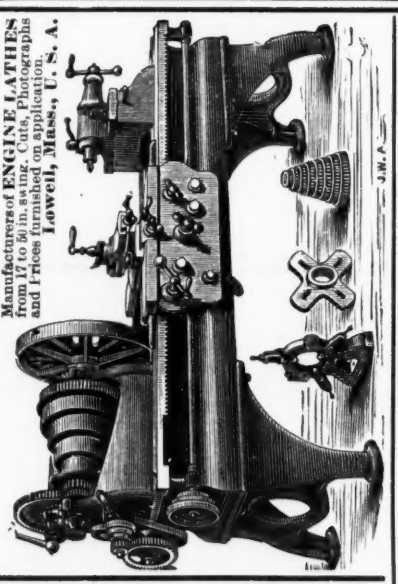

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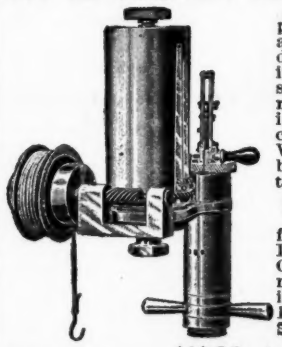

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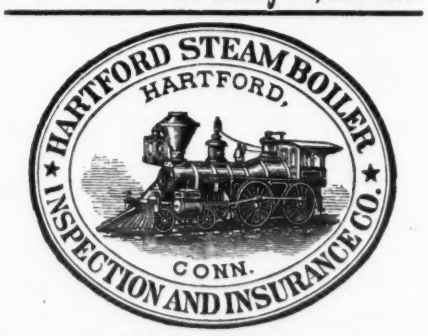

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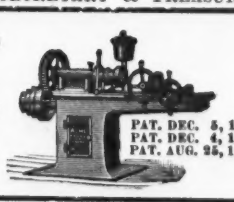

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